



LUDWIG-
MAXIMILIANS-
UNIVERSITÄT
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WIRTSCHAFTS- UND ORGANISATIONSPSYCHOLOGIE
ECONOMIC AND ORGANISATIONAL PSYCHOLOGY
CHAIR: PROF. DR. FELIX BRODBECK



**WOP Working Paper
No. 2006 / 3**

**Group Decision Making in Hidden Profile Situations:
Dissent as a Facilitator for Decision Quality**

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Reference / a later version of this paper was published in:

Schulz-Hardt, S., Brodbeck, F. C. (shared first authorship), Mojzisch, A., & Kerschreiter, R., & Frey, D. (2006). Group decision making in hidden profile situations: Dissent as a facilitator for decision quality. *Journal of Personality and Social Psychology*, 91, 1080–1093. doi:10.1037/0022-3514.91.6.1080

Keywords: Group decision making, information pooling, hidden profile, dissent, minority influence

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Felix Brodbeck and Stefan Schulz-Hardt contributed equally to this article; their authorship order was determined by a coin flip. Parts of the data were presented at the 13th General Meeting of the European Association of Experimental Social Psychology in San Sebastian, Spain, June 2002, and at the 11th European Congress on Work and Organizational Psychology in Lisbon, Portugal, May 2003. The research reported in this article was made possible by grants from the German Scientific Foundation (Deutsche Forschungsgemeinschaft) to Felix Brodbeck, Stefan Schulz-Hardt, and Dieter Frey (Project No. SCHU 1279/1-1). We thank Shanshan Chen, Andrea Csanadi, Marina Deiss, Tanja Deiss, Yasmin Dirkes, Beate Dorsch, Stephanie Flo'ter, Nadira Faulmu'ller, Ingrid Mayer, Simone Schickel, Sybille Schuhwerk, Tatjana Schweizer, Eva Traut-Mattausch, Adriana Tzvetkova, and Martin Winkler for their assistance in collecting the data reported in this article.

Abstract

The effect of diversity in individual pre-discussion preferences on group decision quality was examined in an experiment. Therefore, 135 three-person groups worked on a personnel selection case with four alternatives. The information distribution among group members constituted a hidden profile (i.e., the correct solution was not identifiable on the basis of the members' individual information and could only be detected by pooling and integrating the members' unique information). Whereas groups with homogeneous suboptimal pre-discussion preferences (no dissent) hardly ever solved the hidden profile, solution rates were significantly higher in groups with pre-discussion dissent, even if none of these individual pre-discussion preferences was the correct one. If dissent came from a proponent of the correct solution, solution rates were even higher than in dissent groups without such a proponent. The magnitude of dissent (i.e., minority dissent or full diversity of individual preferences) did not affect decision quality. The beneficial effect of dissent on group decision quality was mediated primarily by more discussion intensity and to some extent also by less discussion bias in dissent groups.

Group Decision Making in Hidden Profile Situations:

Dissent as a Facilitator for Decision Quality

Some 20 years ago, Garold Stasser and William Titus (1985) published their seminal article on group decision making in situations where the decision-relevant information is distributed among members. The authors primarily sought to demonstrate that if a group has all the information available that is necessary to choose the best decision alternative but, in order to detect this alternative, the group members' unique pieces of information have to be exchanged and combined, groups will have difficulties generating the correct solution. Situations like these have subsequently been labeled "hidden profiles" (Stasser, 1988). In a hidden profile, part of the information is shared among group members (i.e., all members possess this information prior to group discussion), whereas other pieces of information are unshared (i.e., information known to only one member prior to discussion). Furthermore, shared and unshared information have different decisional implications, and the alternative implied by the unshared information is the correct one (i.e., this alternative is also implied by the total set of information available to the group). However, no group member can detect this best solution on the basis of her individual information prior to discussion; it can only be found by pooling the unshared information during group discussion. Stasser and Titus (1985) suspected that this information distribution might predispose groups to make suboptimal choices.

This assumption turned out to be true. Whereas in a control condition where all information was shared among members 83% of the groups chose the best alternative, in the hidden profile conditions this solution rate dropped dramatically to only 18% overall. In the meantime, this core finding has been replicated several times (Brodbeck, Kerschreiter, Mojzisch, Frey, & Schulz-Hardt, 2002; Dennis, 1996; Hollingshead, 1996; Kelly & Karau, 1999; Lam & Schaubroeck, 2000; Lavery, Franz, Winkquist, & Larson, 1999; Stasser & Stewart, 1992). Thus, the failure of groups to solve hidden profiles is a robust phenomenon.

However, in their 1985 article Stasser and Titus attempted to demonstrate another phenomenon. Their idea was that groups should be more likely to solve hidden profiles if group members experience dissent about the choice to be made. Whereas in the so-called “unshared / consensus” condition all four group members received individual information that implied Alternative B to be the best choice (given all information, A was best), in the so-called “unshared / conflict” condition two group members received individual information in favor of B, whereas the other two members received individual information that implied C to be the best choice (again, given all information, A was best). The rationale was that two preference factions should emerge in this case, and that the conflict between these two factions should stimulate the exchange of information and the solution of the hidden profile.

Unfortunately, this second suggestion was not confirmed. The solution rate was by no means higher in the conflict condition ($M = 12\%$) than in the consensus condition ($M = 24\%$). This initial failure may explain why this second idea largely escaped attention in the following years. A few more recent hidden profile studies have dealt with minority influence in the hidden profile paradigm (McLeod, Baron, Marti, & Yoon, 1997; Stewart & Stasser, 1998). However, in these studies the minority member was given full information and thus possessed superior knowledge to the other group members. These manipulations do not directly address the question that Stasser and Titus (1985) originally asked – namely whether dissent *per se* would be beneficial for group decision making in hidden profile situations.

The absence of any beneficial effects of the conflict manipulation in the Stasser and Titus (1985) study is striking because, in the group decision making literature, dissent among group members' individual pre-discussion preferences is generally viewed as a facilitator for group decision quality (e.g., De Dreu & Beersma, 2001; Dooley & Fryxell, 1999; Simons, Pelled, & Smith, 1999). In the present paper, we subject the role of dissent in the hidden profile paradigm to a new and methodologically more sound empirical test. We first outline

why understanding the role of dissent is important for both theoretical and practical reasons, and systematically derive predictions about why and how pre-discussion dissent should help groups to solve hidden profiles. We will then report an experiment that was designed to systematically test these ideas.

Dissent as a Facilitator for Solving Hidden Profiles – Theoretical and Practical Importance

As mentioned above, it is widely assumed that group decision quality benefits from pre-discussion dissent. However, a closer inspection of the literature reveals that empirical support for this assumption is weaker than it might seem at first glance. Many studies have dealt with how dissent affects the *process* of group decision making. With this regard, it has been shown that, compared to groups where all members prefer the same alternative prior to group discussion, groups with dissent among group members' pre-discussion preferences show less overconfidence (Sniezek, 1992), are less prone to underestimate risks (Williams & Taormina, 1993), exhibit less group polarization (Smith, Tindale, & Dugoni, 1996), are more open-minded (Tjosvold, Johnson, & Lerner, 1982), exchange more information (Parks & Nelson, 1999), and show less bias to confirm a solution that is currently favored in the group (Schulz-Hardt, Frey, Lüthgens, & Moscovici, 2000). Although such effects are often seen as process improvements, it depends on the underlying model of optimal decision making whether or not they can really be judged as being beneficial (Hart, 1998). Even in the case of findings showing that dissent facilitates multiple perspectives and leads to more creative solutions (Van Dyne & Saavedra, 1996), one might ask whether more creative solutions are necessarily better solutions. Thus, studies investigating decision process without relating it to decision performance do not really tell us whether dissent is in fact beneficial for group decision quality.

In this respect, most evidence for beneficial effects of dissent is rather indirect. In one type of study, other aspects of diversity in groups (e.g., with regard to personality, functional background, or training of group members) have been investigated, and it has been concluded

that predominantly those types of diversity that foster disagreement in the decision-making process are beneficial for decision quality (e.g., Williams & O'Reilly, 1998). A second type of study has examined artificial dissent that was introduced by techniques like devil's advocacy or dialectical inquiry. These manipulations raise the quality of group decisions (see Katzenstein, 1996 or Schwenk, 1990 for reviews). However, neither type of study directly addresses genuine dissent in pre-discussion preferences and, thus, other aspects than dissent might be responsible for the findings (e.g., structuring of the group decision process by means of a dialectical technique).

In a third type of study, the effects of dissenting opinions on *individual* judgments, decision-making processes, and performance have been investigated. Here, exposure to dissenting opinions, especially if they come from a minority, has been shown to raise creativity, quantity, and quality of individual problem solutions (e.g., Nemeth, Rogers, & Brown, 2001; Nemeth & Wachtler, 1983). However, being individually exposed to a diverging opinion (e.g., on a piece of paper or by feedback of the experimenter) and discussing diverging opinions in a group decision process might be two different things, with effects from the former not being necessarily generalizable to the latter.

Finally, in a fourth type of study dissent and group decision quality have been assessed, but with measurement (particularly of dissent) based on retrospective ratings (e.g., De Dreu & West, 2001; Dooley & Fryxell, 1999). This strategy has been predominantly used in research on groupthink (excessive concurrence-seeking in groups; e.g., Janis, 1982; Peterson, Owens, Tetlock, Fan, & Martorana, 1998). However, with retrospective measurement it cannot be ruled out that subjective theories about the determinants of group performance might have contributed to the general finding that better decisions were associated with more dissent. In addition, these studies hardly allow causal inferences to be drawn.

Thus, what is largely missing are experimental studies where pre-discussion dissent is manipulated as an independent variable and group decision (or judgment) quality is measured as a dependent variable. To our knowledge, only three studies approach this design (Brodbeck et al., 2002; Sniezek & Henry, 1989; Wanous & Youtz, 1986); all of which resulted in better decisions being associated with higher diversity in pre-discussion preferences. However, even in these three laboratory studies pre-discussion dissent was only measured, not directly manipulated, leaving open the possibility of causation by common third variables. Furthermore, all three studies do not allow assessment of the effects of preference diversity *per se*, which is independent of the quality of individual judgments and decisions. Without additional experimental control, increasing preference diversity by increasing the range of individual judgments and opinions in a group is likely to increase the possibility that at least one of the members prefers the optimal solution (or a near-by optimal solution) from the beginning, and if this best member can demonstrate the superiority of her solution, the group's solution will also be better (e.g., Laughlin & Ellis, 1986).¹

In sum, an unequivocal test of the effects of pre-discussion dissent on group decision quality requires a situation where dissent can be manipulated independently of the quality of the best member's individual solution. The hidden profile paradigm allows for this. Furthermore, the hidden profile paradigm is also ideally suited for such an investigation if the practical relevance of the dissent topic is considered: In all kinds of political, economic, and societal contexts, important decisions are often made by groups rather than individuals. This "popularity" of groups as decision makers largely stems from the fact that, in most cases, groups possess larger informational resources about a decision problem than individuals (e.g., Clark & Stephenson, 1989). As a consequence, group decisions are expected to be of higher quality than individual decisions (e.g., Vroom & Jago, 1988).

From a practical point of view, it is often this expected surplus in decision quality that is used to justify the higher costs (with regard to time, money, and effort) of group decision

making compared to individual decision making or polls of individual votes. Such surplus is only possible if (most) group members' preferences prior to discussion are suboptimal and exchanging information during discussion has the potential to help them find the best solution. Hidden profiles are a prototype of such situations.

If groups consistently perform suboptimal in situations where their use should be beneficial, interventions are called for that enable groups to deal with this particular type of decision problem more successfully. The search for such interventions has hitherto not been very successful (see Stasser & Birchmeier, 2003, for a review). Thus, finding that pre-discussion dissent fosters a group's ability to solve hidden profiles might open new avenues for such interventions.

Dissent in Pre-discussion Preferences – Why and How Should it Help?

Why should we expect groups with dissent in pre-discussion preferences to perform better in hidden profile situations? To answer this question, one has to take a closer look at the mechanisms that hinder a group from solving a hidden profile. Two such processes have been identified at the group level, both of which are summarized in the *dual process model* by Winquist and Larson (1998):

First, groups often tend to negotiate the final group decision on the basis of their members' pre-discussion preferences rather than openly discussing the available information (Gigone & Hastie, 1993). This *premature preference negotiation* is detrimental for decision quality in hidden profiles because a) hidden profiles predispose group members to individually prefer suboptimal alternatives prior to discussion, and due to this the prematurely emerging consensus will also be suboptimal, and b) premature preference negotiation precludes an intensive discussion of the total information available in the group, and, hence, the group fails to exchange sufficient information to detect the superiority of the best alternative.

Second, even if the group members really engage in discussing the relevant information, their information exchange is systematically biased against the best solution. This *discussion bias* consists of two components (cf. Stasser & Titus, 1985). The first component is that groups introduce more of their shared than unshared information during discussion, simply because the former can be mentioned by more persons than the latter. Once introduced into discussion, shared information is also repeated more often than unshared information (e.g., Larson, Foster-Fishman, & Keys, 1994). The second component is that information is introduced and repeated more often if it supports rather than contradicts the speaker's preference (e.g., Dennis, 1996). In order to solve a hidden profile, the group has to discuss information that is both unshared and inconsistent with most or all group members' individual preferences. As a consequence, group discussion has the potential to correct members' suboptimal individual preferences, but both types of discussion bias work against realizing this potential.²

For both premature preference negotiation and discussion bias it can be predicted that dissent in pre-discussion preferences should help. Premature consensus on the basis of members' pre-discussion preferences should be less likely the more that disagreement exists among these preferences; group members should engage in a more intense debate (compared to homogeneous groups) to argue out the pros and cons of their diverse preferences. In turn, discussion should last longer and more information should be exchanged than in homogeneous groups (Parks & Nelson, 1999). We summarize this by proposing that *dissent intensifies discussion*.

With regard to discussion bias, predictions about a de-biasing effect of dissent can be derived from the literature on minority influence. As Moscovici (1980) points out, being exposed to diverging minority opinions instigates a so-called "validation process" where the person tries to critically test the validity of her own as well as the minority's position by intensively checking the available evidence. Furthermore, Nemeth (1986) argues that minority

influence stimulates divergent thinking, which means that the person openly evaluates all available options, including ones that are proposed neither by themselves nor by the minority. Thus, if a group consists of a minority and a majority faction, these influence processes should make at least the majority members highly receptive to information that is new to them (unshared information) and that contradicts their individual preferences (as shown in studies on group information sampling by Schulz-Hardt et al., 2000, Schulz-Hardt, Jochims, & Frey, 2002). This effect should be even larger if all group members prefer different alternatives, because in this case all members are exposed to minority influence (Brodbeck et al., 2002). In sum, we predict that *dissent debiases discussion*.

It should be noted that these improvements brought about by pre-discussion dissent should be independent of whether or not the group contains a member that favors the best alternative from the beginning. Thus, even if all members prefer suboptimal alternatives, solving the hidden profile should be more likely in groups with pre-discussion dissent than in groups with homogeneous pre-discussion preferences. However, if one of the diverging pre-discussion preferences is in favor of the best alternative, a solution of the hidden profile should be even more likely, because even in the case of premature preference negotiation the best alternative is at least taken into consideration because one group member proposes it.

Some evidence for these predictions was obtained in a study by Brodbeck et al. (2002). In this study, groups with minority dissent continued discussing longer and group members had a higher information gain (i.e., learning unshared information from other group members and being able to retrieve it after discussion) than groups with consensual pre-discussion preferences, independent of whether the minority member was right or wrong. These effects were even stronger in groups where all members preferred different alternatives (so-called “full diversity”). With regard to decision quality, the latter groups showed a superior solution rate (50%) compared to the other conditions (homogeneity: 0%, minority/majority: 5%).

However, for two reasons the Brodbeck et al. (2002) study cannot unequivocally demonstrate the causal impact of pre-discussion dissent on decision quality. First, dissent had only been indirectly manipulated via the underlying information distribution, and – as in the Stasser and Titus (1985) study – this manipulation only worked suboptimally. Due to the fact that the analyses had been carried out on the basis of the actual preference distributions which were only loosely related to the experimental manipulation, causal inferences are difficult to draw. Second, because three-person groups worked on a decision problem with three alternatives, the full diversity groups inevitably contained one group member who preferred the best alternative from the beginning. Thus, the superior decision quality observed in these groups need not necessarily be due to dissent per se; it might also have been a consequence of the fact that the group had a proponent for the correct decision alternative – which, according to almost all social combination models (e.g., Davis, 1973) implies some positive influence on group decision quality.

Overview of the Present Study and Hypotheses

The present study was designed to test whether preference diversity per se is beneficial for the quality of group decision making in the hidden profile paradigm. To this end, pre-discussion dissent had to be operationalized independent of the quality of individual pre-discussion preferences – a precondition that has, to our knowledge, not yet been realized in previous research on group decision quality in general or hidden profiles in particular. This aim was achieved by constructing a decision case with four alternatives for three-person groups, with three equally attractive suboptimal alternatives and one superior decision alternative (the correct solution). As a consequence, full diversity dissent could be obtained without one group member necessarily having to prefer the correct alternative.

In sum, five different hidden profile conditions were realized: 1. No dissent (homogeneous suboptimal preferences), 2. minority dissent with all preferences being suboptimal, 3. full diversity dissent with all preferences being suboptimal, 4. minority dissent

with the minority member favoring the correct choice, 5. full diversity dissent with one member favoring the correct choice. The first three conditions permit testing the pure effect of pre-discussion dissent (labeled *pure dissent effect*), whereas the comparison of conditions 4 and 5 with conditions 2 and 3 tests for the effects of a proponent for the correct solution (the *proponent dissent effect*). Furthermore, comparing conditions 3 and 5 with conditions 2 and 4 permits testing of whether or not full diversity dissent, independent of the presence or absence of a proponent for the correct solution, is more beneficial than minority dissent (the *magnitude-of-dissent effect*).

As outlined above, we expected that pure dissent in the absence of a proponent for the correct choice should facilitate the solution of a hidden profile (pure dissent effect) and that this benefit should be even larger in groups with full diversity dissent (magnitude-of-dissent effect). If dissent comes from a person who favors the correct alternative, the chances of solving the hidden profile should be better than in groups with pure dissent (proponent dissent effect).

As we have also outlined, the pure dissent effect as well as the magnitude-of-dissent effect should be mediated by a higher discussion intensity and a lower discussion bias in groups with more dissent. Both more discussion intensity and less discussion bias should facilitate discussion of the correct alternative because in a hidden profile this alternative is largely supported by unshared information and is inconsistent with the group members' individual pre-discussion preferences. More discussion about the correct alternative should, in turn, make the solution of the hidden profile more likely, because discussing this alternative should increase the likelihood that its superiority is detected.

In contrast to these two effects, the proponent dissent effect need not be related to either discussion intensity or discussion bias. Rather, if the group contains a dissenter who is in favor of the correct choice, this proponent should directly increase discussion about the correct alternative, simply because she expresses and defends her preference. Again, this

should facilitate the solution of the hidden profile. The proposed mediational chains are illustrated in Figure 1.

Method

Participants and Design

All data (pretests and main experiment) were collected from undergraduate and graduate students from the fourth and fifth authors' institution. Four hundred and forty seven students (317 female, 130 male) with an average age of $M = 23.86$ years participated in the experiment, with three persons each forming a group. Participants each received 9 Euros (about 11 Dollars) for their participation. The experiment is based on a one-factorial design with six experimental conditions, five hidden profile conditions and a control condition where group members received complete information (*full information*, no hidden profile). The five hidden-profile conditions were: *homogeneity* (all group members prefer the same suboptimal alternative), *pure minority dissent* (two members prefer the same and the third member prefers a different suboptimal alternative), *pure full diversity dissent* (all three members prefer different suboptimal alternatives), *minority dissent with proponent* (two members prefer the same suboptimal alternative and the third member prefers the best alternative), *full diversity dissent with proponent* (two members prefer different suboptimal alternatives, the third member prefers the best alternative). Finding the correct solution should be less likely in the hidden profile conditions than in the full information condition; this condition was included to make sure that our newly developed decision case operated in accordance with previously used paradigms.

Material

The decision case deals with an airline company looking for a new pilot for long-distance flights. The participants play the role of a member of the personnel selection committee of this airline company. They have to choose between four candidates named A, B, C, and D. In the full information set, each of the four candidates is characterized by 10

attributes that are either positive or negative. These 40 attributes had been selected in a pretest where altogether 100 items were rated by a sample of $N = 112$ students. From this item pool those 40 attributes were chosen that were rated as most unambiguously positive or negative and as being of comparable importance and strength. An example of a positive attribute is: "The candidate is very well able to concentrate over long-term periods". An example of a negative attribute is: "The candidate is said to be a know-it-all". Extremely negative attributes were avoided because it would be implausible for such a candidate to have survived the organizational pre-selection.

The distribution of information about the four candidates is shown in Table 1. Given the full information set, Candidate C is the best choice.³ Whereas this candidate has seven positive and only three negative attributes, all other three candidates (A, B, and D) have four positive and six negative attributes. This ranking was confirmed in a second pretest with $N = 71$ students who were given the profiles with full candidate information. Of these 71 participants, 62 participants (= 87%) chose Candidate C.

In the hidden profile conditions, each member received a subset of this information. For Candidates A, B, and D all positive attributes were shared and all negative attributes were unshared. Thus, for each group member each of the Candidates A, B, and D had four advantages and only two disadvantages prior to discussion. In contrast, all negative attributes and only one positive attribute about Candidate C were shared, with the other six positive attributes unshared. Thus, for each group member Candidate C had three advantages and three disadvantages prior to discussion. As a consequence, most group members should prefer Candidate A, B, or D prior to discussion. However, because the difference in positive and negative attributes is not large and because there is always some variation with respect to what attributes are considered as being the most important ones, at least some participants should also prefer Candidate C (which allows the formation of groups with a proponent for the correct choice).

These expectations were confirmed in a third pretest with $N = 83$ students. Each participant received one of the three individual pre-discussion profiles (differing only with regard to the particular unshared items in the profile). Of these, 21 (= 25%) chose Candidate A, 27 (= 33%) chose Candidate B, 26 (= 31%) chose Candidate D, and only 9 (= 11%) chose Candidate C, the best candidate given the full information. Thus, all pretests confirm that our decision case material successfully induces a hidden profile.

Procedure

Either six, nine, or twelve persons were invited for each experimental session, which was conducted in a university laboratory setting. If one or two persons did not arrive, the remaining one or two persons that could not participate in a three-person group were assigned to a different experiment. The participants were welcomed by the experimenter and briefly informed about the procedure and aims of the experiment. Specifically, it was emphasized that the experiment focuses on the process and quality of group decision making. To investigate this, the participants would first receive and work on individual material about a personnel selection case in an airline company. Afterwards, they would be assigned to groups that should make a common, final decision about which of the four candidates the airline company should hire. The group discussion would be videotaped, with the videos exclusively being used for scholarly purposes. If participants did not agree to being videotaped, they were assigned to a different experiment.

The experimenter then handed out a cover letter where the decision case was introduced and some basic information about the airline company and the selection situation was provided. On this sheet, the participants also indicated their sex, age, and their principal subject at the university. In addition, they were given a code to use on all subsequent questionnaires. The code consisted of a three-digit-number as well as an "X", "Y", or "Z"; this letter indicated whether they would be group member X, Y, or Z in the following group discussion.

The experimenter then handed out a candidate information sheet and an information evaluation questionnaire. On the candidate information sheet, each of the four candidates A, B, C, and D was characterized by six attributes. Three versions of this information sheet existed, one each for prospective X-, Y- and Z-members. The three versions did not differ with regard to the number of positive and negative attributes about the candidates (see Table 1) but with regard to the specific unshared items that this participant received. Taken together, an X-, a Y-, and a Z-profile in combination contained the full information about the four candidates.

The participants were then asked to deeply elaborate the information about the candidates and memorize them because later on during the discussion they would not have access to the candidate information sheets. To support this elaboration and fixation phase, they had to write down the attributes on the information evaluation questionnaire word by word and rate each attribute with regard to how positive or negative it was for the suitability of the particular candidate. Fifteen minutes were given for this task. Afterwards, the participants had an additional 10 minutes to fix on and learn the information. Finally, they were asked to indicate on a separate questionnaire which of the candidates they individually preferred as the new pilot for their airline company. All information sheets and questionnaires were then collected by the experimenter.

On the basis of the individual preference questionnaires, three-person groups were assembled by the experimenter. The assignment of participants to groups was conducted as randomly as possible, but with some restrictions. Each group had to consist of one X-, one Y-, and one Z-member. In addition, because a random assignment is least likely to lead to homogeneous preferences (with three alternatives being equally attractive in the beginning), the experimenters were instructed to build homogeneous groups whenever possible. A slightly larger number of homogeneous groups compared to the other conditions was also intended because, in the statistical analyses this single condition would be contrasted with the mean of

two other conditions (pure minority dissent and pure full diversity dissent). Finally, due to the fact that we could not influence how many participants would prefer Candidate C in the beginning, building groups with proponents (for this best alternative) was also partially a non-random process.

Each three-person group was seated at a table in a different room and had a separate experimenter running the group session. This experimenter took care that the three members took their places in accordance with the pre-determined seating plan for members X, Y, and Z. The experimenter also started the video-camera and then took care that the group members read through an “instruction to group discussion” sheet that had previously been handed out. In accordance with previous hidden profile research, these instructions emphasized that only part of the group members' individual information was identical and that each group member also had some information that was unique. In addition, it was emphasized that on the basis of the full information set held within the group one of the candidates clearly was the best choice, and that it was the group's task to find out this correct solution. If the group arrived at the correct choice in the end, each group member would be entered into a raffle and could win one of 25 music CD vouchers. In accordance with prior hidden profile research, a unanimous group decision about the candidate to be chosen was required.

After the experimenter had made sure that all group members had completely understood these instructions, the group started its discussion. No time limit was set. However, if a decision had not been reached within 45 minutes, the experimenter briefly interrupted the discussion and pointed out that it would now be time to make the final decision. This only occurred in five groups (with the longest discussion taking 55 minutes).

When the group stated that the final decision had been made, the experimenter handed out a questionnaire on which this decision was noted. Afterwards, the three members were separated and seated at different tables. Each member was given a recall questionnaire on which they wrote down all attributes about each candidate that they could remember.

Thereafter, the experiment was finished. The experimenter thanked the participants, gave them their participation credit, and briefly explained the theoretical background of the experiment. Participant also entered their e-mail-address on a list before they were dismissed. On completing the whole experiment, all participants received a document via e-mail, indicating the correct solution, the code numbers of those persons who had won the CD vouchers, and additional information about hidden profiles and the role of dissent. On average, the whole experimental session took about 100 minutes.

Dependent Measures

The main dependent variable was decision quality, which was dichotomous (choice of the optimal candidate vs. choice of one of the suboptimal candidates) and could be directly derived from the group decision questionnaire.

Those dependent measures that were expected to mediate dissent effects on decision quality were derived from the discussion videotapes. Discussion time (as one indicator of discussion intensity) was directly available from the videos. To assess information exchange, the videotapes were analyzed by two coders who were blind to the experimental hypotheses but were trained in coding the discussion content. Coding was done by noting on a specifically designed form item by item which item was mentioned by which of the group members. The coders received a written manual with specific instructions and the coding criteria. The coding criteria defined which deviations from the original wording were tolerable for an item to be counted as a correct mentioning. In addition, for a statement to be counted as a correct mentioning the group member had to link the information to the corresponding candidate explicitly or by context. If one of these criteria was not fulfilled, an item was not coded. If an item had been mentioned by some other group member before or had previously been mentioned by the same group member, with at least one other item having been mentioned in between, it was coded as a repetition.

One coder coded all 118 discussions that were subsequently entered into data analyses (see results section). To estimate coding reliability, a second coder independently coded 22 of these discussions, randomly selected from each condition with largely equal numbers across conditions. The two coders agreed on 87% of coded statements. For the data analyses, the data from the first coder were used.

From these data, all dependent variables with regard to discussion content were derived. These include proportion of mentioned information and repetition rates overall (as indicators of discussion intensity) as well as separate measures for mentioning and repetition of shared vs. unshared information and preference-consistent vs. preference-inconsistent information. From these separate measures, the discussion bias variables were computed (see results section). Mentioning and repetition of information for each of the four alternatives was also computed, in order to identify the information exchanged about the correct alternative (Candidate C) which is the most proximal mediator (proximal to the criterion) in our proposed mediation chains (see Figure 1).

From the final individual recall questionnaire, the additional variable “information gain” was derived. An information gain was counted each time a group member correctly recalled an item she had not received in the beginning. Thus, the magnitude of the information gain shows how much unshared information the particular group member has learned from other members during discussion. Other possible dependent variables from this questionnaire are not mentioned here, as they are not considered in the results section.

Results

Of the 149 three-person groups in the sample, 14 groups (from all experimental conditions) had to be discarded due to technical problems with the videotapes. For the remaining 135 groups, no reliable effects of participants’ age or gender on the main dependent variables were found.

In the following, we will first report analyses of the decision quality measure in order to test our central hypotheses regarding the beneficial effects of dissent on decision quality. Then, we will report analyses of discussion intensity and discussion bias dependent on dissent in order to test whether these variables qualify for mediation in accordance with our hypotheses. In both parts of the analyses, overall tests of the complete experimental design are followed by planned comparisons to test for our three dissent effects (pure dissent effect, proponent dissent effect, magnitude-of-dissent effect). In the final part of the analyses, mediation analyses are reported for the previously identified possible mediators.

Decision Quality

Overall, 59 of 135 groups (= 44%) made the correct decision. A chi-square-analysis of decision quality (1 = solved, 0 = not solved) across the six experimental conditions revealed significant differences between these conditions, $\chi^2(5, N = 135) = 51.31, p < .001$; the corresponding percentages are given in Figure 2. To clarify these differences, subsequently planned comparisons in accordance with our hypotheses were conducted. First of all, the full information condition differed significantly from the hidden profile conditions, $\chi^2(1, N = 135) = 28.48, p < .001$. Whereas all 19 groups (100%) in the full information condition chose the correct candidate, only 40 of the 116 groups (35%) in the hidden profile conditions made the correct choice. This replication of the well-known hidden-profile-effect confirms that our newly created decision case works as intended.

To test the pure dissent effect, the pure minority dissent condition and the pure full diversity dissent condition were compared with the homogeneity condition. This comparison was significant, $\chi^2(1, N = 74) = 4.07, p = .044$. Whereas only 2 of 28 (7%) homogeneous groups made the correct choice, 12 of 46 (26%) pure dissent groups (with either minority or full diversity dissent) solved the hidden profile. The proponent effect was also significant, $\chi^2(1, N = 88) = 11.48, p = .001$: Compared with the above-mentioned 12 of 46 (26%) pure

dissent groups, 26 of 42 (62%) dissent groups (either minority or full diversity dissent) with a proponent for the correct choice were successful in solving the hidden profile. In contrast, no significant magnitude-of-dissent effect occurred, $\chi^2(1, N = 88) = 0.03, p = .953$: Solution rates were almost identical for minority dissent groups with or without a proponent (20 of 46 were correct = 44%) and for full diversity groups with or without a proponent (18 of 42 were correct = 43%).

Discussion Intensity

For all of the following analyses only the five hidden profile conditions were considered because only in those conditions can mediators for the dissent effects on decision quality be identified. (In the full information condition, information exchange is relatively meaningless for the final decision because, all group members have all information from the beginning and, thus, overwhelmingly start the discussion with the correct solution in mind.)

Discussion intensity was assessed by three indicators, namely proportion of information mentioned, average repetition rate of information, and discussion time. In one-factorial ANOVAs, significant effects of the dissent factor emerged for each of the three variables: $F(4, 111) = 7.02, p < .001, \eta^2 = .20$ for proportion of information mentioned, $F(4, 110) = 8.13, p < .001, \eta^2 = .23$ for repetition of information, and $F(4, 111) = 5.75, p < .001, \eta^2 = .17$ for discussion time.⁴ Because in one of the homogeneous groups no information was mentioned at all (discussion only consisted of exchanging preferences and subsequently choosing the candidate that was favored by all members), the repetition rate for this group could not be calculated. Hence, the degrees of freedom for analyses concerning repetitions are diminished by one. The corresponding means and standard deviations are given in Table 2.

Planned comparisons revealed that the dissent conditions differed significantly from the homogeneous groups on each of these three measures: Groups in the four dissent conditions introduced a higher proportion of information into discussion ($M = 71\%$) than

homogeneous groups ($M = 54\%$), $t(32.097) = 3.66, p = .001$, dissent groups repeated mentioned information more often ($M = 2.28$) than homogeneous groups ($M = 1.06$), $t(110) = 5.56, p < .001$, and dissent groups also spent longer in discussion ($M = 25.81$) than homogeneous groups ($M = 15.18$), $t(111) = 4.50, p < .001$. Within the dissent groups, groups with a proponent for the correct solution did not differ from groups without such a proponent on any of the three measures, all $|t|s < 1.10$, all $ps > .30$. However, full diversity dissent led to somewhat higher discussion intensity than minority dissent: Groups with full diversity dissent introduced even more information ($M = 74\%$) than groups with minority dissent ($M = 67\%$), $t(76.01) = 2.54, p = .013$, with the latter still significantly differing from the homogeneous groups ($M = 54\%$), $t(39.52) = 2.75, p = .009$. For discussion time, the trend goes in the same direction ($M = 27.74$ for full diversity dissent; $M = 23.88$ for minority dissent, $M = 15.18$ for homogeneous groups), but whereas the difference between minority dissent and homogeneity becomes significant, $t(111) = 3.32, p = .001$, the difference between full diversity dissent and minority dissent falls short of significance, $t(111) = 1.65, p = .101$. No such trend was observed for the repetition rate of information ($M = 2.25$ for minority dissent, $M = 2.31$ for full diversity dissent), $t(110) = 0.30, p = .77$.

To calculate an overall measure of discussion intensity, the three variables (discussion time, amount of information introduced, average repetition rate of information) were z-transformed and then averaged. To avoid loss of information, in this as well as all subsequent similar analyses those groups that had missing values for a dependent variable were assigned the mean of their experimental condition for that dependent variable. In this analysis, this was done for the repetition rate of the one homogeneous group that did not exchange any information.

The dissent factor had a significant effect on this overall measure of discussion intensity, $F(4, 111) = 10.02, p < .001, \eta^2 = .27$. Planned comparisons revealed that discussion intensity was higher in the four dissent conditions ($M = 0.24$) than in homogeneous groups (M

= -0.75), $t(35.23) = 4.98, p < .001$. Within the dissent conditions, discussion intensity was marginally higher in the two full diversity conditions ($M = 0.36$) than in the two minority dissent conditions ($M = 0.11$), $t(75.63) = 1.81, p = .074$, however, the two minority dissent conditions still differ significantly from the homogenous groups, $t(39.48) = 4.97, p < .001$. Groups with a proponent for the correct solution did not significantly differ from groups without such a proponent, $t(39.48) = 0.48, p = .633$.

Discussion Bias

Discussion bias was calculated separately for shared vs. unshared and for preference-consistent vs. preference-inconsistent information.

Shared vs. unshared information. Overall, a higher proportion of shared information ($M = 79\%$) than unshared information ($M = 55\%$) was introduced into discussion, $F(1, 111) = 310.90, p < .001, \eta^2 = .74$. In addition, shared information, once it had been introduced into discussion, was repeated more often ($M = 2.22$) than unshared information ($M = 1.78$), $F(1, 110) = 21.24, p < .001, \eta^2 = .23$. To calculate the amount of bias in favor of shared information, the introduction (repetition) rate of shared information was divided by the sum of the introduction (repetition) rates for shared and unshared information (for a similar bias measure see Stasser, Vaughan, & Stewart, 2000). This bias measure ranges between 0 and 1; a value of .50 indicates that discussion is unbiased. The larger the value, the more discussion is biased towards shared information. Because one of the groups did not exchange any information (see above) neither of the two bias measures could be calculated for this group. Furthermore, one other group did not repeat any mentioned information. Hence, for this group the repetition bias can not be calculated.

The average introduction bias in favor of shared information was .59, which is significantly different from .50, $t(114) = 15.71, p < .001$. In an overall ANOVA, the effect for the experimental conditions was not significant, $F(4, 110) = 1.10, p = .360, \eta^2 = .04$. The

corresponding means are shown in Table 3. Planned comparisons revealed a marginal difference between homogeneous groups and dissent groups, $t(110) = 1.74, p = .084$: Dissent groups ($M = .59$) had a somewhat lower bias towards shared information than homogeneous groups ($M = .61$). The comparisons within the dissent groups (minority dissent vs. full diversity dissent; dissent with proponent vs. dissent without proponent) did not reach significance, both $|t|s < 1.10$, both $ps > .28$.

The average repetition bias was .57; again, this bias significantly differs from .50, $t(113) = 5.11, p < .001$. With regard to this bias, significant overall differences were found in the ANOVA, $F(4, 109) = 2.61, p = .040, \eta^2 = .09$. The corresponding means are also shown in Table 3. Planned comparisons revealed that homogeneous groups had a larger repetition bias ($M = .64$) than groups with dissent ($M = .54$), $t(28.52) = 2.25, p = .032$. Again, no significant differences were found within the dissent groups, both $|t|s < 0.80$, both $ps > .42$.

Preference-consistent vs. preference-inconsistent information. Because the preference-consistency of information depends on the individual pre-discussion preference of the speaker, and because in most conditions these preferences are not homogeneous, it is not possible to determine the proportion of discussed preference-consistent and preference-inconsistent information in the same way as in the case of shared and unshared information. The problem is that the same piece of information that is consistent for one member can be inconsistent for another member. Hence, if one member introduces a piece of information that is preference-consistent for her, this reduces another member's possibilities for preference-inconsistent information introductions. After careful investigation, we decided that in a hidden profile situation there is no appropriate way to calculate a preference-consistency bias for the *introduction* of information that a) tells us whether there is in fact a bias towards preference-consistent information (i.e., that leads to an unequivocal reference value for an unbiased discussion against which the empirical bias values can be tested) and b) allows for a fair test

between the experimental conditions.⁶ Hence, we concentrated on information repetitions when analyzing discussion bias towards preference-consistent information.

A preference-consistent repetition was counted each time a group member repeated an advantage of her preferred candidate or a disadvantage of the non-preferred candidates. The amount of preference-consistent repetitions per member was divided by the total amount of mentioned information that was preference-consistent for this member, and the resulting values for the three members were summed up. Hence, this repetition rate for preference-consistent information tells us how often, on average, a mentioned piece of information was repeated as a preference-consistent information (and vice versa for preference-inconsistent repetitions). Overall, the repetition rate was higher for preference-consistent information ($M = 2.17$) than for preference-inconsistent information ($M = 1.83$), $F(1, 110) = 27.81, p < .001, \eta^2 = .23$.

To calculate the repetition bias similarly to the case of shared vs. unshared information, the repetition rate for preference-consistent information was divided by the sum of the two repetition rates. Hence, the resulting bias measure has the same characteristics as the corresponding measures for shared information (range between 0 and 1; value of .50 indicates unbiased discussion, larger values show stronger bias towards preference-consistent information). The average bias was .57, which is significantly different from .50, $t(113) = 5.07, p < .001$.

An overall ANOVA of the experimental conditions shows significant differences with regard to the repetition bias, $F(1, 109) = 3.71, p = .007, \eta^2 = .12$; for the corresponding means see Table 3. Planned comparisons revealed that dissent groups ($M = .54$) had a lower repetition bias than homogeneous groups ($M = .65$), $t(28.30) = 2.61, p = .014$. Within the dissent groups, no significant differences were found, both $|t|s < 0.66$, both $ps > .50$.

Average discussion bias. As for discussion intensity, an overall bias measure was calculated. To give sharedness and preference-consistency equal weight in this average bias measure, first the two sharedness biases were averaged, and the resulting measure was then averaged with the preference-consistency bias (z-transformation was not necessary at this point because all three measures ranged on the same scale). The mean of this average discussion bias across the experimental conditions was $M = 0.57$, which is significantly different from .50, $t(114) = 8.49$, $p < .001$. The dissent factor had a significant effect on this average discussion bias, $F(4, 110) = 4.86$, $p = .001$, $\eta^2 = .15$; the means are shown in Table 3. According to the planned comparisons, groups in the four dissent conditions had a lower discussion bias ($M = 0.55$) than homogeneous groups ($M = 0.63$), $t(29.10) = 2.95$, $p = .006$. No significant effects occurred within the dissent conditions, both $|t|s < 0.70$, both $ps > .48$.

Discussion about Candidate C (optimal candidate)

Discussion about the optimal candidate (introduction and repetition of information about Candidate C) was analyzed in two 5×1 ANOVAs of the experimental design. Because four homogeneous groups did not mention any information about Candidate C, repetition rates could not be calculated for these groups.

In the overall analyses, significant effects of the dissent factor emerged for both dependent variables, $F(4, 111) = 10.25$, $p < .001$, $\eta^2 = .27$ for proportion of information introduced about Candidate C, and $F(4, 107) = 5.88$, $p < .001$, $\eta^2 = .18$ for repetition rate of information about Candidate C. The corresponding means and standard deviations are given in Table 4.

Planned comparisons revealed that dissent groups without a proponent for Candidate C introduced more information about Candidate C ($M = 58\%$) than homogeneous groups ($M = 46\%$), $t(45.47) = 1.99$, $p = .053$, and repeated information about Candidate C more often ($M = 1.67$) than homogeneous groups ($M = 1.04$), $t(107) = 1.70$, $p = .093$. Compared to dissent

groups without a proponent for Candidate C, dissent groups with such a proponent introduced even more information about that candidate ($M = 77\%$), $t(69.07) = 4.99, p < .001$, and repeated such information even more often ($M = 2.75$), $t(107) = 3.40, p = .001$. No differences were found between minority dissent and full diversity dissent, both $|t|s < 0.78$, both $ps > .44$.

As for discussion intensity and discussion bias, an average measure for discussion about Candidate C was calculated. Therefore, the two separate measures (introduction and repetition rate) were z -transformed and averaged, again with assigning the means of the corresponding experimental condition to those cases where repetition rates could not be calculated. The dissent factor significantly affected this measure, $F(4, 111) = 10.82, p < .001$, $\eta^2 = .28$. Planned comparisons revealed that dissent groups without a proponent for Candidate C discussed significantly more about this candidate ($M = -0.17$) than homogeneous groups ($M = -0.62$), $t(111) = 2.44, p = .016$. Dissent groups with a proponent for Candidate C discussed even more about this candidate ($M = 0.57$) than dissent groups without such a proponent, $t(111) = 4.47, p < .001$. No significant difference occurred between minority and full diversity dissent, $t(111) = 0.50, p = .62$.

Mediation Analyses

We now test for mediation of the dissent effects on decision quality. Two such effects have been reported: Dissent groups without a proponent for the correct candidate had a higher solution rate than homogeneous groups (pure dissent effect), and dissent groups with a proponent for the correct candidate had an even higher solution rate than dissent groups without such a candidate (proponent dissent effect). The proximal mediator (proximal to the criterion) was assumed to be discussion about the correct candidate. This assumption was tested in a first step. Subsequently, it was investigated how pure dissent affects this mediator itself, that is, why dissent groups without a proponent for Candidate C discuss more about this candidate.

All mediation analyses were conducted in accordance with the criteria of R. M. Baron and Kenny (1986). According to these criteria, mediation can be shown in three separate regression analyses if (1) the independent variable significantly affects the dependent variable, (2) the independent variable significantly affects the mediator, and (3) the regression weight for the independent variable is zero (full mediation) or reduced (partial mediation) if the dependent variable is regressed on both the mediator and the independent variable, whereas the mediator receives a significant regression weight in this multiple regression. In all of the following analyses, we report beta-weights and statistics from linear regressions, although in the case of decision quality the criterion is dichotomous. We do that to maximize comparability across the different steps and analyses. If binary logistic regression is used for the latter cases, similar results are obtained.

Dissent effects on decision quality. We first tested whether the pure dissent effect on decision quality is mediated by discussion about Candidate C. In a simple regression analysis with decision quality as the criterion, the pure dissent contrast (i.e., the contrast between homogeneous groups on the one hand and dissent groups without a proponent for Candidate C on the other hand) received a significant regression weight, $\beta = .235$, $p = .044$, showing that higher solution rates are found in dissent groups (without a proponent for the correct solution) than in homogeneous groups. The same occurs if the mediator, average discussion about Candidate C, is regressed on this contrast, $\beta = .263$, $p = .023$, showing that dissent groups discuss more about Candidate C than homogeneous groups. In the final step, decision quality was regressed on both discussion about Candidate C and the pure dissent contrast, $F(2, 71) = 29.05$, $p < .001$. In this analysis, discussion about Candidate C received a significant regression weight, $\beta = .652$, $p < .001$, whereas the regression weight for the dissent contrast was near zero and no longer significant, $\beta = .063$, $p = .492$. Hence, the pure dissent effect on decision quality is mediated by the amount of discussion about the correct alternative.

A similar process was followed for the proponent dissent effect on decision quality. In a simple regression analysis with decision quality as the criterion, the proponent dissent contrast (i.e., the contrast between dissent groups with vs. without a proponent for Candidate C) received a significant regression weight, $\beta = .361$, $p = .001$, indicating that more correct solutions were found in dissent groups with a proponent for the correct choice than in dissent groups without such a proponent. The contrast also received a significant regression weight if average discussion about Candidate C is regressed on it, $\beta = .434$, $p < .001$, showing that dissent groups with a proponent for Candidate C discuss more about this candidate than dissent groups without such a proponent. Again, the final step was to regress decision quality on both discussion about Candidate C and the proponent dissent contrast, $F(2, 85) = 32.93$, $p < .001$. In this analysis, discussion about Candidate C received a significant regression weight, $\beta = .614$, $p < .001$, whereas the regression weight for the dissent contrast is reduced by more than two thirds and no longer significant, $\beta = .095$, $p = .299$. Hence, the proponent dissent effect on decision quality is also mediated by discussion about Candidate C.

Dissent effects on discussion of Candidate C. Both dissent effects on decision quality have been shown to be mediated by discussion about the correct candidate. Whereas it is not surprising that groups with a proponent for Candidate C discuss more about this candidate (proponent dissent effect), it is far less evident why dissent groups without a proponent for Candidate C discuss more about this candidate than homogeneous groups. In the introduction we have proposed that this occurs as a consequence of higher discussion intensity and lower discussion bias in dissent groups. These predictions were subjected to additional mediation analyses. However, conducting these analyses on the basis of the intensity and bias measures already defined raises the problem that the criterion and the mediators are logically dependent: The more a group discusses Candidate C, the higher necessarily is the overall discussion intensity, and the lower necessarily is the discussion bias. Therefore, the latter two

measures were recalculated on the basis only of discussion about Candidates A, B, and D (i.e., discussion about Candidate C was removed from the information exchange measures).

As already reported, pure dissent groups discussed more about Candidate C than homogeneous groups, $\beta = .263, p = .023$. With regard to the mediators, pure dissent groups had a higher discussion intensity, $\beta = .566, p < .001$, and a lower discussion bias $\beta = -.242, p = .037$, than homogeneous groups. If discussion about Candidate C is regressed on both the pure dissent contrast and discussion intensity, $F(2, 71) = 15.44, p < .001$, the regression weight for discussion intensity is significant, $\beta = .586, p < .001$, whereas the influence of the pure dissent contrast is completely eliminated, $\beta = -.076, p = .571$. Thus, discussion intensity mediates the pure dissent effect on discussion about Candidate C. (If the three components of discussion intensity are separately analyzed as mediators – which, due to space considerations, we do not report here – less powerful mediation effects occur for each separate measure.)

If the same analysis is conducted with discussion bias instead of discussion intensity, $F(2, 71) = 5.94, p = .004$, the discussion bias also receives a significant regression weight, $\beta = -.280, p = .016$, indicating that less discussion bias is associated with more discussion about Candidate C. The regression weight for the pure dissent contrast is reduced and no longer significant, $\beta = .195, p = .089$, indicating a weak partial mediation. However, discussion intensity seems to be the more powerful of these two mediators. This is supported by a multiple regression where both discussion intensity and discussion bias are entered as predictors together with the pure dissent contrast (criterion = discussion about Candidate C). In this significant regression analysis, $F(3, 70) = 10.37, p < .001$, only discussion intensity receives a significant regression weight, $\beta = .546, p < .001$, whereas the regression weight for discussion bias is non significant, $\beta = -.078, p = .497$. As before, the influence of the pure

dissent contrast is eliminated, $\beta = -.065$, $p = .594$, indicating that mediation has been successfully shown.

For the proponent dissent effect on discussion about Candidate C, no such distal mediators as discussion intensity or discussion bias have been proposed because the existence of a proponent for Candidate C in the group should directly increase discussion about that alternative. If discussion about Candidate C is nevertheless regressed on discussion intensity, discussion bias, and the proponent dissent contrast, the regression weight for this contrast, $\beta = .532$, $p < .001$, is not reduced when compared to a simple regression, $\beta = .434$, $p < .001$. Thus, neither discussion intensity and nor discussion bias has a mediating function for the proponent dissent effect on discussion about Candidate C.

Overall mediational analysis for the pure dissent effect. The prior analyses indicate that pure dissent in pre-discussion preferences increases discussion intensity and decreases discussion bias, both of which increase discussion about the correct alternative, and this increase raises the likelihood that the hidden profile is successfully solved. As a final test for this mediational chain, all three mediators were entered a multiple regression analysis as predictors together with the pure dissent contrast with decision quality as the criterion. If our prediction were correct, only the proximal mediator (discussion about Candidate C) should receive a significant regression weight. This was found to be the case in an overall significant multiple regression, $F(4, 69) = 15.76$, $p < .001$. While the regression weight for discussion about Candidate C was significant, $\beta = .746$, $p < .001$, non-significant regression weights were obtained for discussion intensity, $\beta = -.244$, $p = .066$, discussion bias, $\beta = -.035$, $p = .727$, and the pure dissent contrast, $\beta = .168$, $p = .118$. Although the regression weight for discussion intensity is marginal, it should be noted that the sign has changed, indicating that the facilitative effect of discussion intensity on the solution of hidden profiles completely vanishes if discussion about Candidate C is controlled for.

Additional findings

Information gain. Information gain (i.e., the amount of unshared information per group that the members had learned from the other members, as evident from the recall questionnaire) was analyzed in a one-factorial ANOVA of the experimental design. A significant overall effect emerged, $F(4, 111) = 5.04, p = .001, \eta^2 = .15$; the means are displayed in Table 4. Planned comparisons revealed that dissent groups ($M = 9.54$) had a higher information gain than homogeneous groups ($M = 5.21$), $t(111) = 4.31, p < .001$. Within the dissent groups, no significant differences were found, both $|t|s < 0.57$, both $ps > .57$. In an additional analysis, the proportion of unshared information mentioned as well as the repetition rate for unshared information (both of which were higher in dissent groups than in homogeneous groups, see Footnote 4) were entered as covariates. In this case the overall effect, $F(4, 108) = 0.53, p = .712, \eta^2 = .02$ as well as the planned comparison between dissent groups and homogeneous groups, $F(1, 111) = 1.49, p = .224$, were no longer significant. Thus, the higher information gain in dissent groups seems to be a consequence of their more intense discussion of unshared information.

Majorities vs. minorities. In two of the five hidden profile conditions (the minority dissent conditions), majority members could be compared with minority members; in one of these two conditions the minority member was the proponent for the correct solution. Neither with respect to discussion intensity (proportion of information introduced, repetition rate of information) nor with respect to discussion bias (in favor of shared and/or preference-consistent information) or information gain did we find any significant differences between minority and majority members, all $ps > .20$.

Discussion

The goals of the present hidden profile experiment were threefold: a) to provide for an unequivocal test of the effects of pre-discussion dissent on group decision making (*pure*

dissent effect) while controlling for the effects of a proponent for the correct solution within a group (*proponent dissent effect*), b) to test for differential effects of minority versus full diversity dissent on group decision making (*magnitude-of-dissent effect*) and c) to examine the extent to which discussion intensity, discussion bias, and the amount of information about the correct decision alternative discussed mediate dissent effects on group decision quality.

In line with our hypotheses, we found that both minority and full diversity dissent in pre-discussion preferences have positive effects on group discussion and group decision quality. Of particular importance is the finding that even if none of the group members prefers a correct decision alternative (all hold suboptimal preferences), positive effects of diversity are still evident. In other words, any dissent in pre-discussion preferences (right or wrong) improves group decision making and decision quality when the best choice is not evident for the members from their individual information (hidden profile). When a proponent of the correct solution is among diversity group members, there is an even higher likelihood that hidden profiles are solved as compared to diversity groups where all members enter group discussion with a suboptimal preference. Counter to our expectations, the dissent effects on decision quality were not affected by the amount of dissent (minority-majority dissent vs. full diversity dissent).

Our experiment not only demonstrates *that* pre-discussion dissent improves decision quality in hidden profile situations, but also *how* decision quality is improved by dissent. As predicted, both the pure dissent effect and the proponent dissent effect were mediated by discussion about the correct candidate: Because dissent groups exchanged more information about the best alternative and repeated it more often, they were more likely to solve the hidden profile. However, the two dissent effects differ with regard to how these increases in discussion about the best alternative are achieved. The proponent dissent effect is directly mediated via discussion about the best candidate. Thus, a proponent who happens to prefer

the correct alternative (often termed “best-member” within a group) seems to help group decision making mainly by keeping discussions about the correct decision alternative alive.

In contrast, in diverse groups which are “blind” to the correct alternative because none of their members proposes the correct alternative, the increase of discussion about the correct candidate is achieved via two different mechanisms. On the one hand, diversity in pre-discussion preferences results in higher levels of discussion intensity, that is, more information (shared and unshared) is introduced and repeated during group discussion which also takes more time. As a consequence of this higher discussion intensity, the group also introduces and discusses more information about an alternative that initially has not been preferred by any group member – namely the best alternative. On the other hand, groups with pre-discussion dissent conduct a less biased discussion than groups without pre-discussion dissent, that is, members of preference-diverse groups focus less on information that is shared and consistent with their initial preferences. It is not surprising that this debiasing mainly affected the *repetition* rather than the *introduction* of information. We had predicted that dissent should make group members more open to new (unshared) and inconsistent information, but at least in the case of unshared information this greater openness and receptivity can not directly affect the introduction of information because, before a piece of information is introduced into discussion no group member knows whether it is shared or not. As a consequence of this greater openness to new and inconsistent information, the group is also more open to discuss an alternative that has not been preferred by any group member before discussion – the best alternative.

With regard to these two processes, mediation analyses revealed discussion intensity to be the more important. Not only did discussion intensity receive a stronger regression weight in separate mediation analyses than did discussion bias, in the common mediation analysis discussion intensity also mediated on its own whereas discussion bias mediated only

in conjunction with discussion intensity (i.e., the variance common to discussion intensity and discussion bias is relevant for the criterion). Based on the pattern of results, one might even suspect that the mediation effect of discussion bias is spurious, so that only discussion intensity would matter. However, what strongly speaks against this interpretation is the fact that in several hidden profile studies, pure increases in discussion intensity did not result in significant effects on group decision quality (e.g., Hollingshead, 1996; Mennecke, 1997). The evidence from these studies speaks to a different interpretation within which a reduction in discussion bias is seen as a necessary ingredient alongside higher discussion intensity for increasing solution rates in a hidden profile.

Although the focus of our experiment was on decision quality, it should be emphasized that pre-discussion dissent also facilitates individual learning of new information not held before discussion (information gain) which is mediated by an increased proportion of unshared information discussed. Thus, pre-discussion dissent is not only beneficial for group decision quality, it also fosters the acquisition of new knowledge by group members – a process that may, for example, be helpful in the implementation phase of a group decision by helping group members to better anticipate consequences of their decision.

Implications for Dissent Research

The results of our experiment provide what is, to the best of our knowledge, the first methodologically sound empirical demonstration that group decision quality benefits from pre-discussion dissent independent of the quality of the members' individual judgments or preferences. In contrast to previous studies (Brodbeck et al., 2002; Sniezek & Henry, 1989; Wanous & Youtz, 1986), the design of our experiment completely rules out the alternative explanation that the dissent effect may, at least partially, be based on the fact that an increase in preference diversity, on average, also increases the likelihood that at least one of the members prefers the optimal or a near-by optimal solution – which should also be beneficial for group decision quality. Hence, our study provides an empirical foundation for the claim

that decision-making units should be composed of members with different opinions in order to maximize decision quality (e.g., Janis, 1982).

Relating the current experiment to previous hidden profile studies. Some previous studies have reported beneficial effects of minority influence on the solution of hidden profiles (McLeod et al., 1997; Stewart & Stasser, 1998). However, because in these studies the minority members were given full information about the decision case, the information distribution did not fully match the defining conditions of a hidden profile (namely that *no* group member can identify the best alternative based on her individual information). As a consequence, these members' individual information should have led them to prefer the best alternative prior to discussion (because the best alternative can be clearly identified when full information is given), which should have made them act as proponents for this alternative during discussion. Therefore, the findings of McLeod et al. (1997) as well as Stewart and Stasser (1998) are more closely related to our proponent effect than to our pure dissent effect. However, it should be noted that in our experiment the proponents did not have superior information compared to the other group members, whereas such superiority was clearly present in the two other studies. Hence, higher competence or higher expert status (cf. Wittenbaum, 1998) may have been attributed to the fully informed group members in these studies, which may have facilitated their influence on the other group members. In our experimental design the distributions of information and preferences were independently manipulated, making sure that facilitative effects of proponents for the correct choice on group decision quality can be identified as "pure" proponent effects.

An important implication of our study is that, 20 years after its publication, the second central idea expressed in Stasser and Titus' (1985) seminal article has proven to be valid – namely that conflict initiated by pre-discussion dissent among group members facilitates the solution of hidden profiles even if no group member initially favors the best alternative. This leads to the question of why we were able to show an effect that Stasser and Titus (1985)

failed to demonstrate. One difference between the two studies is that Stasser and Titus aimed to investigate dissent brought about by two conflicting factions, each consisting of two persons with homogeneous preferences, whereas we investigated minority-majority-compositions and groups composed of three persons that all differed with regard to their individual pre-discussion preference. It is thus possible that the dissent situation investigated by Stasser and Titus (1985) leads to different influence processes (e.g., less minority influence) than the preference distributions that we investigated. Systematically investigating such “faction dissent” is an interesting topic for further research in order to test possible limiting conditions for the dissent effects that we found.

However, another possible explanation for the absence of dissent effects in Stasser and Titus’ study is methodological in nature, as was argued by Brodbeck et al. (2002). Stasser and Titus attempted to manipulate pre-discussion dissent via a manipulation of conflicting patterns of pre-discussion *information*, so that consequently such manipulation only partially resulted in the expected conflicting patterns of *pre-discussion preferences*. Brodbeck et al. (2002) calculated a maximum of only 15 out of 57 groups (i.e., 27%) in which Stasser and Titus obtained a match between manipulated information distribution and actual preference distribution in the group (Stasser & Titus, 1985, Table 4, p. 1474). Thus, it seems possible that not enough dissent was introduced to warrant significant effects on group discussion and decision quality. Again, this problem was circumvented in our study by manipulating preference distributions independently of how information was distributed within the group.

Magnitude-of-dissent effect. In line with the theoretical reasoning and the results reported by Brodbeck et al. (2002) we hypothesized stronger effects of full diversity as compared to minority dissent conditions on group decision making. This was only weakly supported by our findings. Only discussion intensity differed to some extent between these two conditions, which was largely due to significantly more information being introduced in full diversity groups compared to groups with minority dissent. However, despite these

improvements in group discussion, no improvements in group decision quality were evident.

One explanation for these findings draws on the different hidden profiles used in the study reported by Brodbeck et al. (2002) as compared to our study. In the hidden profile material used by Brodbeck et al. (2002), the total distribution of information “in favor” ($N = 6$) versus “against” the best decision alternative ($N = 3$) as compared to each of the suboptimal alternatives (3 versus 3) is less distinct than in the profile used in the present study (7 versus 3 for the correct alternative as compared to 4 versus 6 for each suboptimal alternative). In a less distinct distribution of information high discussion intensity is necessary to solve the hidden profile because a comparatively large proportion of the total information needs to be discussed for the best alternative to become evident. In a distinct distribution of information, the proportion of the information to be discussed which is necessary to solve the hidden profile is lower. Thus, in the Brodbeck et al. (2002) study the higher levels of discussion intensity introduced by full diversity groups may have been necessary to bring about a significant increase in solution rates (while minority groups mainly failed to solve the hidden profile), whereas in the present study the discussion intensity introduced by minority dissent may have already been sufficient to ensure solution rates that are similar to the solution rates full diversity groups could produce. Further research is needed to clarify the conditions under that full diversity dissent can be more beneficial to group decision quality than minority dissent.

Minority versus majority members in minority dissent groups. Theories about minority influence (e.g., Moscovici, 1980; Nemeth, 1986) suggest that for diversity groups with clear minority and majority factions it is to be expected that a minority exerts its influence in group decision making through the majority members. This means for the present study that the majority members should show more discussion intensity and less repetition bias in favor of shared and preference-consistent information than respective minority members do. However,

our data shows no evidence for any differences in information exchange behavior between minority and majority group members. The data suggest that all members in minority dissent groups display equally more discussion intensity and less repetition bias than members from homogeneous groups do. How is this to be explained?

One explanation is that in our three-person minority dissent groups, the minimal minority/majority ratio of 1:2 does not make the majority member status salient enough to warrant significant differences in their information processing as compared to minority members. In classic minority research (cf. Moscovici, 1980; Nemeth, 1986) larger minority/majority ratios (1:3, 1:4, etc.) are often used, which may make the majority vs. minority member status more salient to the participants. It would be interesting to see whether our pattern of results changes if more extreme minority/majority ratios are used in subsequent studies on pre-discussion dissent in hidden profile situations.

Another explanation also seems plausible. It derives from a further difference between the classic paradigm used to investigate minority influence and the group interactive setting which was used in our study. Research about minority and majority influence is usually conducted either completely outside the dynamic context of face-to-face group discussion or in a discussion with confederate group members who either act solely as minority or as majority group members (for an exception see, for example, Smith et al., 1996). Thus, each influence process, majority and minority influence, is studied in isolation as a pure effect, and may therefore be stronger than in face-to-face groups. In the case of our study, where face-to-face group discussion is practiced, minority and majority influence processes are not necessarily isolated from each other. In a face-to-face group decision making context it seems plausible that a person *temporarily* adopts an authentic position that differs from her pre-discussion preference (which usually is evaluated before group discussion begins). In a three person group this can make her a temporary member of a faction that differs from her positioning at the beginning of group discussion. She may switch from being a minority

member at the beginning to a majority in the middle or end of group discussion and vice versa. The temporary adoption of preferences that differ from previously held preferences does not usually happen when minority and majority influence is investigated in isolation. Because the discussion bias variables measured in our study summarize the information exchange behavior during overall group discussion, they are insensitive to majority/minority role transitions. It therefore seems likely that it is an unknown mixture of minority and majority influence that results, on the one hand, in increased discussion intensity and reduced repetition bias for minority and majority members from minority dissent groups as compared to members from homogeneous groups, and on the other hand, in no differences between minority and majority members within minority dissent groups.

Implications for SDS Research

Social decision scheme (SDS) models try to predict the final group decision solely on the basis of the group members' pre-discussion preferences (e.g., Davis, 1973; Stasser, Kerr, & Davis, 1989). A common prediction that can be derived from all decision schemes discussed in this literature (e.g., truth wins, truth supported wins, majority rule, plurality rule, proportionality etc.) is that the final group decision must be an alternative that has been favored by at least one group member prior to discussion. In other words, a decision alternative that finds no proponent among group members prior to discussion should not be adopted, and this is indeed what most studies on group decision making demonstrate (cf. Stasser, 1999; Stasser, et al., 1989; see also Hollingshead, 1996). The current experiment provides a notable exception from this rule by showing that if members' pre-discussion preferences are heterogeneous, a substantial proportion of these groups choose the best alternative even if none of the group members entered group discussion with a preference for this alternative. This points at a blind spot in SDS research because, from an SDS perspective, diversity versus homogeneity of initial preferences should not affect the probability of finding the correct solution if all of these initial preferences are suboptimal. Thus, perhaps future

developments on SDS should take into account that under certain conditions decision schemes are needed that predict group decisions that were not initially favored by any group member.

At first glance, the proponent dissent effect demonstrated in our experiment seems to be far less noteworthy than the pure dissent effect. Some evidence already exists showing that hidden profiles are more likely to be solved if at least one group member favors the best alternative prior to discussion (Sassenberg, Boos, & Klapproth, 2001), and this is also what most social decision schemes would suggest. However, a closer inspection shows that the solution rates in the proponent conditions are relatively high (65% and 59%), although only one group member favored the correct solution at the beginning. This is remarkable because, those social decision schemes that the SDS literature suggests as plausible for our task predict lower solution rates. Because the task has a correct solution and this fact is communicated to the group, we should classify it as an intellectual task (Laughlin, 1980). If we classified it as being judgmental in nature, then the best-fitting scheme would be a “majority wins” scheme, which would predict no solutions at all in the minority dissent conditions. For intellectual tasks, the best-fitting scheme depends on whether or not a member who prefers the correct solution can demonstrate the superiority of this alternative to the other members (Laughlin & Ellis, 1986). If this is the case, a “truth wins” scheme fits the actual decision outcomes best (i.e., if the group contains a proponent for the correct solution, this proponent will “win” the discussion), whereas in the case of no demonstrability at least two proponents for the correct solution are needed in order for the group to select this solution (“truth supported wins”).

If we apply this to our hidden profile task, we see that no demonstrability was given in terms of Laughlin and Ellis (1986): The proponents did not have sufficient information individually to demonstrate that their preferred candidate was unequivocally the best. Hence, a majority of correct group choices in these conditions should only have occurred if the proponent had had a supporter – which was not the case. Because of this lack of supporters

“truth supported wins” is not applicable, from an SDS perspective we should have expected the groups to use a secondary decision scheme. Plausible candidates would be “majority” or “proportionality” (the probability of the group choosing a particular alternative is proportional to the number of supporters that this alternative has prior to discussion), but none of these decision schemes would give the best alternative a chance of more than 33% of being chosen. However, the actual solution rates are clearly higher and more in the direction of a “truth wins” scheme that requires demonstrability to be applicable.

On the basis of these findings we argue that in a hidden profile, demonstrability can emerge from social interaction. Although no single group member can demonstrate the superiority of the correct choice before discussion, sufficient information can be *generated* to increase the demonstrability of the correct decision alternative, as is proposed in Laughlin and Hollingshead’s (1995) theory of collective decision making. Our findings indicate that generating sufficient information can be achieved via information exchange. Group members can demonstrate the information portfolio they collectively hold for one alternative to be superior to the portfolios they hold about all other decision alternatives. This makes the actual group task in a hidden profile an intellectual task with a demonstrably correct solution, which can only be identified and demonstrated if sufficient information is exchanged. This “collective demonstrability” might add a refreshing perspective to the SDS literature and group decision making research in general.

Practical Implications

Our results demonstrate that group decision quality benefits from pre-discussion dissent among group members. Thus, if high decision quality is required, organisations should attempt to design committees and other decision-making groups with at least some amount of pre-discussion dissent among their members. Although our results do not demonstrate a superiority of full diversity dissent over minority-majority dissent (at least not with regard to decision quality), from a practical point of view one should prefer to realize full diversity

dissent for two reasons. The first is that pre-discussion dissent is useless if the dissenting opinions are not expressed. In organizations, members of decision-making groups often withhold diverging views (Stanley, 1981), which can be due to formal or informal communication barriers (R. A. Baron & Greenberg, 1989), evaluation apprehension (Gallupe, Bastianutti, & Cooper, 1991), or conformity pressures within the group (Janis, 1982). In a group with a highly diverse preference distribution, it should be more likely that dissent will be expressed than in a group with a large majority and a small minority faction because less conformity pressure operates and more people can express dissent in the former than in the latter group. The second reason is that the two dissent effects that were separately demonstrated in our study, namely the pure dissent effect and the proponent dissent effect, are to some extent confounded in real-world decision making: The more diverse the preference distribution in the group is, the more likely it is that the group contains at least one member with a preference for the best alternative. Thus, maximizing pre-discussion dissent raises the likelihood of capturing not only the pure dissent effect, but also the proponent dissent effect.

It should be noted that pre-discussion dissent is not without costs. Once established, authentic dissent is likely to result in prolonged group discussion, lower cohesiveness and conflict in natural groups (e.g., Jehn, Northcraft, & Neale, 1999; Williams & O'Reilly, 1998) which increases the propensity of disengagement from the task, the group, or both. These drawbacks can be counteracted when group members develop a shared identity (cf. van Knippenberg & Haslam, 2003) that promotes the understanding that diversity in opinion can promote higher decision quality via collective demonstrability.

As already outlined above, pre-discussion dissent is worthless if it is not expressed, which points at the necessity to accompany pre-discussion dissent by measures that facilitate the expression of such dissent. On the one hand, this is a leader task and requires participative instead of directive leadership. As Larson, Foster-Fishman, and Franz (1998) have shown, group decision quality benefits from participative (as opposed to directive) leadership if the

leader's individual information implies the choice of a suboptimal alternative (as it is the case in a hidden profile). Although not directly investigated in that study, one reason for this effect may be that directive leadership discourages dissenting opinions to be expressed and, thus, the leader's suboptimal individual preference remains uncorrected. On the other hand, the expression of dissent becomes more likely if a norm of critical discussion prevails in the group. As shown by Postmes, Spears, and Cihangir (2001), such critical norms raise decision quality in hidden profile situations. Again, one reason for this effect may be that those groups that benefit from critical norms are characterized by some amount of pre-discussion dissent.

Whereas in the above interpretation participative leadership and critical norms are seen as moderators for the effects of pre-discussion dissent, it is also possible that they substitute these effects, that is, if participative leadership is enacted and critical norms are prevalent among group members, even homogeneous groups could discuss and decide like preference-diverse groups. Finding such substitutes for the effects of pre-discussion dissent is particularly important for practical reasons because using pre-discussion dissent as an intervention for decision-making groups is only possible if a) the group is composed for one particular decision or, at least, group composition is not fixed and b) the preferences of potential group members are known in advance. Although this may often be the case (e.g., a committee having to decide on which candidate to appoint), many important decisions are made by groups that interact over longer periods (e.g., managerial boards) and make multiple decisions during that time, so that it is hardly possible to change their composition for each single decision. Therefore, substitutes for the effects of authentic pre-discussion dissent are needed for such groups, and it will be a challenge for future research to show how such beneficial dissent effects can be successfully mimicked in hidden profiles situations.

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Footnotes

¹ In the case of the Wanous and Youtz (1986) study, the problem is even somewhat more complicated. Wanous and Youtz used two variants of the “moon survival task” for their study, which requires a group to rank-order 15 items according to their importance for survival. Diversity was assessed as the inverse of the concordance of individual pre-discussion rankings. Before regressing solution quality on diversity, Wanous and Youtz entered the best member’s solution quality as a covariate, which seems to rule out the problem mentioned. However, because these survival tasks consist of multiple subtasks (ranking the different items separately), different “best members” for at least some of the different subtasks should exist. Thus, increasing the diversity of individual solutions increases the likelihood that the group contains a member with a correct (or almost correct) ranking for any specific item, and this effect is not statistically controlled for in the Wanous and Youtz study.

² The failure of groups to solve hidden profiles is not exclusively caused by group processes. As recent studies have shown, biases in the individual evaluation of information also contribute to this failure. On the one hand, shared information is judged to be more credible and more important than unshared information because it can be socially validated (Wittenbaum, Hubbell, & Zuckerman, 1999), and because it is owned by each group member prior to discussion (Van Swol, Savadori, & Sniezek, 2003). On the other hand, preference-consistent information is judged to be more credible and important than preference-inconsistent information because consistent information is accepted at face value, while inconsistent information is tested more critically (Greitemeyer & Schulz-Hardt, 2003). As already discussed for the case of the discussion bias, the information that is critical for the solution of a hidden profile is both unshared and preference-inconsistent. Hence, this biased evaluation of information is detrimental for decision quality in hidden profile situations (Greitemeyer & Schulz-Hardt, 2003). However, due to the fact that we did not measure information evaluation in our experiment (which is difficult to realize in real group

discussions), we abstain from deriving predictions for the impact of pre-discussion dissent on this process here.

³ To be precise, we also had a second, rotated version where Candidate A was the best choice. However, for the sake of simplicity and clarity, methods and results are presented according to the unrotated version. No differences between these two versions occurred in our experimental data.

⁴ Separate analyses for shared and unshared information confirmed that dissent facilitates the introduction of both shared and unshared information, $F(4, 111) = 5.12, p = .001, \eta^2 = .16$ and $F(4, 111) = 6.90, p < .001, \eta^2 = .20$, as well as the repetition of both shared and unshared information, $F(4, 110) = 5.55, p < .001, \eta^2 = .17$ and $F(4, 110) = 8.19, p < .001, \eta^2 = .23$.

⁵ If broken numbers for degrees of freedom occur, this is due to correction for non-homogeneous variances. Variances were considered to be non-homogeneous if $p < .10$ in the corresponding test for homogeneity of variances.

⁶ To give just one illustration: The typical form of preference-consistent information introduction is to mention the advantages of the preferred candidate. Now, if we consider homogeneous groups in our experiment, these are the same four advantages for all three members. Hence, each group member can only mention one third of these advantages on average. In contrast to that, in a full diversity dissent group, each group member can mention all four advantages of her preferred candidate. One might try to solve this problem by calculating the introduction bias only on the basis of the unshared items (see also Dennis, 1996). However, in this case no fair comparison with the proponent dissent groups is possible, because for the proponents all unshared items are preference-consistent.

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The research reported in this article was made possible by grants from the German Scientific Foundation (Deutsche Forschungsgemeinschaft [DFG]) to the first, second and fifth author, project no. SCHU 1279/1-1. Parts of the data have been presented at the 13th General Meeting of the European Association of Experimental Social Psychology in San Sebastian, 2002, and at the 11th European congress on Work and Organizational Psychology in Lisbon, 2003. We would like to thank Shanshan Chen, Andrea Csanadi, Marina Deiss, Tanja Deiss, Yasmin Dirkes, Beate Dorsch, Stephanie Flöter, Nadira Faulmüller, Ingrid Mayer, Simone Schickel, Sybille Schuhwerk, Tatjana Schweizer, Eva Traut-Mattausch, Adriana Tzvetkova, and Martin Winkler for their assistance in collecting the data reported in this paper.

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Table 1

Distribution of Information in the Hidden Profile Conditions

Information Type and Valence	Candidate			
	A	B	C	D
Shared information				
Positive	4	4	1	4
Negative	0	0	3	0
Unshared information				
Positive	0	0	6	0
Negative	6	6	0	6
Information available to each individual				
Positive	4	4	3	4
Negative	2	2	3	2
Full information available to the group				
Positive	4	4	7	4
Negative	6	6	3	6

Table 2:

Means for discussion intensity measures dependent on experimental condition (standard deviations in brackets)

	Experimental condition				
	Homogeneity (<i>N</i> = 30)	Pure minority dissent (<i>N</i> = 26)	Pure full diversity dissent (<i>N</i> = 20)	Minority dissent with proponent (<i>N</i> = 20)	Full diversity dissent with proponent (<i>N</i> = 22)
Proportion of information introduced	.54 (.22)	.69 (.14)	.73 (.09)	.66 (.14)	.75 (.11)
Repetition rate of information	1.06 (0.94)	2.39 (1.10)	2.39 (1.05)	2.11 (0.99)	2.23 (0.89)
Discussion time	15.18 (13.41)	24.31 (8.01)	27.15 (9.10)	23.45 (10.04)	28.32 (12.36)
Average discussion intensity (z-scores)	-0.75 (0.98)	0.19 (0.57)	0.35 (0.62)	0.03 (0.71)	0.38 (0.72)

Table 3:

Means for discussion bias measures dependent on experimental condition (standard deviations in brackets)

	Experimental condition				
	Homogeneity (<i>N</i> = 30)	Pure minority dissent (<i>N</i> = 26)	Pure full diversity dissent (<i>N</i> = 20)	Minority dissent with proponent (<i>N</i> = 20)	Full diversity dissent with proponent (<i>N</i> = 22)
Proportion of shared information introduced	.67 (.29)	.80 (.14)	.87 (.10)	.76 (.16)	.87 (.12)
Proportion of unshared information introduced	.42 (.19)	.57 (.15)	.59 (.13)	.56 (.15)	.63 (.12)
Introduction bias in favor of shared information	.61 (.09)	.59 (.05)	.60 (.06)	.58 (.06)	.58 (.04)
Repetition rate of shared information	1.22 (1.00)	2.61 (1.62)	2.66 (1.44)	2.30 (1.14)	2.50 (1.12)
Repetition rate of unshared information	0.90 (1.00)	2.16 (0.99)	2.13 (0.88)	1.92 (0.90)	1.96 (0.83)
Repetition bias in favor of shared information	.64 (.21)	.53 (.13)	.55 (.11)	.54 (.07)	.56 (.08)
Repetition rate of preference-consistent information	1.18 (0.94)	2.57 (1.36)	2.66 (1.19)	2.30 (1.10)	2.35 (0.96)
Repetition rate of preference-inconsistent information	0.93 (1.00)	2.19 (1.02)	2.17 (0.98)	1.92 (1.00)	2.11 (0.92)
Repetition bias in favor of preference-consistent inf.	.65 (.21)	.54 (.09)	.56 (.08)	.54 (.13)	.53 (.08)
Average discussion bias	.63 (.14)	.55 (.06)	.56 (.06)	.55 (.08)	.55 (.04)

Table 4:

Means for discussion about Candidate C (correct choice) and information gain dependent on experimental condition (standard deviations in brackets)

	Experimental condition				
	Homogeneity (<i>N</i> = 30)	Pure minority dissent (<i>N</i> = 26)	Pure full diversity dissent (<i>N</i> = 20)	Minority dissent with proponent (<i>N</i> = 20)	Full diversity dissent with proponent (<i>N</i> = 22)
Proportion of information introduced about Candidate C	.46 (.26)	.58 (.18)	.58 (.22)	.77 (.13)	.77 (.15)
Repetition rate of information about Candidate C	1.04 (1.07)	1.72 (1.68)	1.63 (1.67)	2.95 (1.65)	2.55 (1.24)
Average discussion about Candidate C (z-scores)	-0.62 (0.75)	-0.15 (0.83)	-0.19 (0.90)	0.63 (0.70)	0.51 (0.63)
Information gain	5.21 (4.46)	9.42 (5.07)	9.10 (4.04)	9.10 (5.00)	10.55 (4.40)

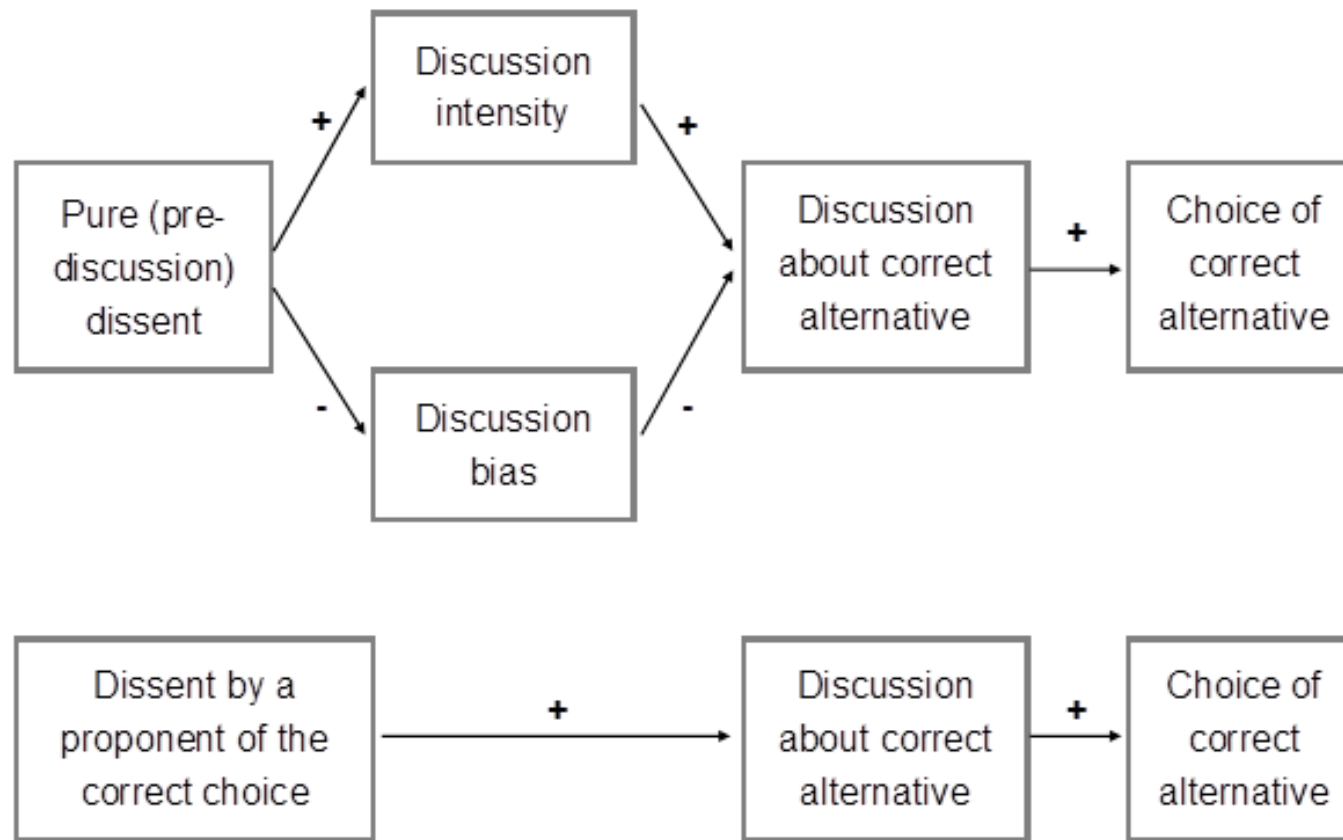


Figure 1. Proposed effects of pure dissent and proponent dissent on decision quality via group discussion.

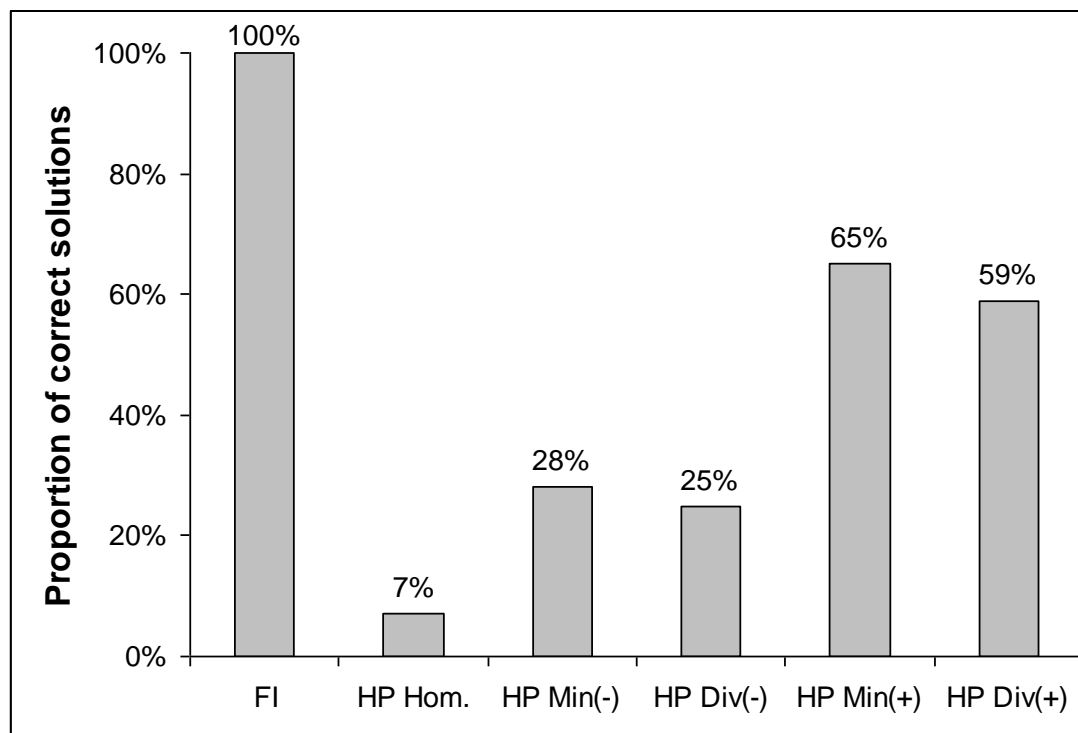


Figure 2. Proportion of correct group decisions dependent on dissent.

Note. FI = full information, all group members received all information, no hidden profile; HP Hom. = hidden profile, homogeneous preferences with no proponent of the correct solution; HP Min. (-) = hidden profile with minority / majority distribution of preferences and no proponent of the correct solution; HP Div. (-) = hidden profile with full diversity distribution of preferences and no proponent of the correct solution; HP Min. (+) = hidden profile with minority / majority distribution of preferences and one proponent of the correct solution; HP Div. (+) = hidden profile with full diversity distribution of preferences and one proponent of the correct solution.