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The Adaptive Use of Recognition in Group Decision Making

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Abstract

Applying the framework of ecological rationality, the authors studied the adaptivity of group decision making. In detail, they investigated whether groups apply decision strategies conditional on their composition in terms of task-relevant features. The authors focused on the recognition heuristic, so the task-relevant features were the validity of the group members' recognition and knowledge, which influenced the potential performance of group strategies. Forty-three three-member groups performed an inference task in which they had to infer which of two German companies had the higher market capitalization. Results based on the choice data support the hypothesis that groups adaptively apply the strategy that leads to the highest theoretically achievable performance. Time constraints had no effect on strategy use but did have an effect on the proportions of different types of arguments. Possible mechanisms underlying the adaptive use of recognition in group decision making are discussed.

Keywords: Group decision making; Recognition heuristic; Adaptive strategy choice; Recognition-based model; Group discussion

1. Introduction

How do groups and individuals make decisions, and what factors influence their decision processes? Interestingly, the social psychology literature on group decision making and the cognitive psychology literature on individual decision making have addressed very similar questions, yet these two bodies of literature are largely unconnected. Here,

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we show that it could be fruitful to combine the two to investigate an important aspect of group decision making: Do groups select decision strategies adaptively, given their composition in terms of some task-relevant features, and if so, how? The framework of ecological rationality has been applied successfully to study these questions in individuals, and here we show how it can be combined with classic models of group decision making to gain important insights in both research areas.

Teamwork has become a common form of organizational collaboration (Meyer, Shemla, & Schermuly, 2011; Salas, Cooke, & Rosen, 2008), especially to handle complex problems. Among the major advantages of groups being discussed are (a) that they possess the potential to pool more information and combine multiple perspectives (Larson, Foster-Fishman, & Keys, 1994; Stasser, 1992); (b) that work can be divided among several group members; and (c) that working in groups creates a sense of satisfaction and well-being (Scholl, 2005). On the other hand, research on social loafing (Karau & Williams, 1993) and groupthink (Janis, 1972) has shown that teamwork and decision processes in teams can also be dysfunctional (for a review on group performance, see Kerr & Tindale, 2004). For example, people may be less motivated when working in a group than when working alone (Latané, Williams, & Harkins, 1979) and suffer from coordination losses (Steiner, 1972).

As the performance of teams can influence organizational success (Peterson, Owens, Tetlock, Fan, & Martorana, 1998), it is crucial to understand how groups make decisions. An important aspect of real-world decisions in organizations is that the decision makers are confronted with a variety of (and dynamic) task environments. Hence, not all decision strategies are viable for every particular task or situation. For example, there is ample evidence that the success of different decision strategies for combining individual inferences is conditional on certain task characteristics (Davis, 1992). Groups have been found to have a good potential to adapt to different (dynamic) environments (cf. Burke, Stagl, Salas, Pierce, & Kendall, 2006; Kämmer, Gaissmaier, & Czienskowski, 2013; Randall, Resick, & DeChurch, 2011). Research has suggested, for example, that context variables and task demands indeed affect which strategies are selected by groups (e.g., Davis, 1973). On the other hand, research has also shown that groups are far from perfect in adapting their strategies. For instance, studies on the truth-wins principle have suggested that groups often overlook a correct solution to a problem if the member who favors it cannot demonstrate its correctness (Laughlin & Ellis, 1986; Laughlin, VanderStoep, & Hollingshead, 1991).

Another important aspect (and unique feature) of groups (as opposed to individuals) is their composition and its effect on the success of different decision strategies. Hence, not all strategies are viable for all groups. For instance, some strategies may need more expert knowledge than others, (Einhorn, Hogarth, & Klempner, 1977). Given the practical relevance and the ambiguous empirical findings, it is particularly important to understand if and how groups adapt their decision-making process to both the composition of their group members and the structure of the task environment.

We propose the framework of ecological rationality to study the adaptivity of group decision making in detail. This framework assumes that people possess an "adaptive toolbox" (Gigerenzer & Gaissmaier, 2011; Gigerenzer & Goldstein, 1996; Gigerenzer &

Selten, 2001; Gigerenzer, Todd, & the ABC Research Group, 1999), that is, a repertoire of specialized decision strategies, with which they can solve specific tasks in specific environments. Importantly, none of the available strategies is an all-purpose tool that can be successfully applied to every situation. Rather, the success of a strategy is anchored both in the structure of the task environment and how well the strategy fits in this regard, and in the cognitive capabilities of the mind. Together, these features determine which strategy is selected (e.g., Simon, 1956).

Groups can be conceptualized as information-processing systems where cognition is distributed across individuals (Hinsz, Tindale, & Vollrath, 1997). We therefore propose that the notion of the adaptive toolbox can be applied to groups as well. On the group level, the success of a strategy is still anchored in the structure of the task environment, as it is for individuals. But instead of the cognitive capabilities of one human mind, what matters on the group level are the cognitive capabilities of several human minds and the composition of the groups. This approach is consistent with frameworks of group performance that point to the importance of input variables, task characteristics, and appropriate group processes for successful group functioning (e.g., Bottger & Yetton, 1988; Hackman, Brousseau, & Weiss, 1976; Steiner, 1972). In a different set of studies, we showed that groups adapt their decision strategies to the structure of the task environment (Kämmer et al., 2013; see also Reimer & Hoffrage, 2012). Here, we investigated a specific notion of adaptivity, namely, if and how groups adaptively select a particular decision strategy dependent on the group composition with respect to a task-relevant feature. We focused on a very simple decision strategy that has been studied extensively in individuals: the *recognition heuristic* (Goldstein & Gigerenzer, 2002).

> Recognition heuristic: If one of two alternatives is recognized and the other is not, then infer that the recognized alternative has the higher value with respect to the criterion.

The recognition heuristic is only applicable in situations in which individuals recognize just one of two objects. In these cases, the recognition heuristic predicts that the recognized object will have the higher value on some outside criterion. If both objects are recognized, people cannot rely on recognition to discriminate between the two but have to rely on further knowledge. The exact nature of this knowledge and how it is applied is not further specified for the purpose here (see Goldstein & Gigerenzer, 2002). Thus, to clarify the terms used in this paper, relying on knowledge in this context means only that both objects are recognized and are distinguished based on some other strategy than recognition (see also, e.g., Reimer & Katsikopoulos, 2004). Finally, individuals who recognize neither object are assumed to guess.

Besides being well researched in individuals, this heuristic is highly suitable for studying adaptive decision making in groups because it (a) is a precisely specified decision model, allowing its success for each group to be assessed and (b) has been previously shown to play an important role in the context of group decision making (Reimer & Katsikopoulos, 2004).

According to the notion of adaptivity, we expect that for some groups it is more worthwhile to follow the recognition heuristic than for others. This allows us to find out if groups rely on recognition in an adaptive manner. That is, do groups that would benefit from using the recognition heuristic rely on it more than groups that would not benefit from using it? What variables influence if a group will rely heavily on recognition? And how can groups tell if they should rely on recognition?

We first introduce research on the recognition heuristic in individuals before describing how it applies to the group context. Then, we spell out in more detail what our specific questions and predictions are regarding adaptive decision making in groups.

1.1. The recognition heuristic in individuals

The recognition heuristic is a prominent decision strategy in choice tasks for at least two reasons: First, recognition has a natural retrieval advantage over knowledge, which, by contrast, has to be searched for in memory with cognitive effort (Pachur & Hertwig, 2006). The recognition heuristic exploits the capacity for recognition, which is fundamental to the human mind (Standing, 1973). Because of this retrieval advantage, the recognition heuristic is often regarded as a default decision strategy (Marewski, Gaissmaier, Schooler, Goldstein, & Gigerenzer, 2010). The second reason is an ecological one. Failure to recognize a name can be informative and facilitate decision making. Environmental mediators such as the media make it more likely that people encounter objects in their daily lives that are well known and score high on a variety of criteria than objects that score low. Consequently, objects scoring high on a criterion are often also more likely to be recognized. It was shown, for instance, that people are more likely to recognize larger cities (Goldstein & Gigerenzer, 2002), more successful political parties (Gaissmaier & Marewski, 2011), better colleges (Hertwig & Todd, 2003), and companies with high market capitalization (Marewski & Schooler, 2011). In domains with such interrelations and for people whose recognition rate highly correlates with the criterion (i.e., who have a high recognition validity, cf. Table 1), it is ecologically rational to rely on the recognition heuristic (Gigerenzer & Goldstein, 2011).

Table 1
Dependent measures

Measure	Explanation
Recognition validity α	α $R/(R + W)$, "where R is the number of correct (right) inferences the recognition heuristic would achieve, computed across all pairs in which one object is recognized and the other is not, and W is the number of incorrect (wrong) inferences under the same circumstances" (Goldstein & Gigerenzer, 2002, p. 78)
Knowledge validity β	Proportion of correct answers when both objects are recognized
Predictive accuracy of the RBM and KBM	Percentage of correctly predicted group choices a model makes for pairs in which it is applicable
Theoretical accuracy of the RBM and KBM	Relative frequency with which a model yields correct choices in pairs in which it is applicable
Achieved accuracy/ performance	Observed number of correct choices per group

KBM, knowledge based model; RBM, recognition based model.

Over the last 10 years of research on the recognition heuristic, evidence has been provided that people indeed adopt this heuristic in environments in which it yields accurate inferences (for a review, see Gigerenzer & Goldstein, 2011; for an overview of current studies, see special issues edited by Marewski, Pohl, & Vitouch, 2010, 2011a,b; for a critical position, see Hilbig, 2010; and Pohl, 2011), namely, people appear to select their strategies in an adaptive way by relying on recognition information when recognition is systematically related to a criterion but discounting it when it is not related (e.g., Pachur & Hertwig, 2006; Pohl, 2006). Hence, there is a positive correlation of $r = .64$ between the recognition validity and the proportion of judgments consistent with the recognition heuristic across 11 studies (Pachur, Todd, Gigerenzer, Schooler, & Goldstein, 2011).

1.2. Recognition-based decision models in groups

Given the importance that recognition has for individual decisions, and to understand the decision process of groups better, it is important to clarify how groups are influenced by their members' recognition or lack thereof when forming joint judgments. Imagine a situation in which a number of people are asked to jointly infer which of two objects scores higher on a criterion. Some group members recognize only one of the two objects and form their inference on the basis of the recognition heuristic. Other members will only guess, while still others are more knowledgeable and base their inference on additional information, which they retrieve from memory.

How do groups integrate their members' individual inferences in the described situation? The recognition heuristic applies to situations in which correct answers exist but where exact criterion knowledge is not available. Thus, without additional sources the correctness of a solution cannot be demonstrated. This kind of task shares many features with a judgmental task (Davis, 1992; Laughlin, 1980), in which some form of a majority rule will best model the decisions of a group (Hastie & Kameda, 2005; Laughlin & Ellis, 1986). The most common majority rule is the simple majority rule, which states that each group member has the same influence on a group decision, and that the group chooses the option that receives the most votes. Reimer and Katsikopoulos (2004) proposed two additional rules—restricted majority models that assign group members different weights in the voting process dependent on their individual decision strategy. These models thus take into account the way in which members have processed information individually and how this affects the group outcome (cf. Reimer & Hoffrage, 2012). The recognition-based model (RBM) assumes that members using the recognition heuristic are more influential, whereas the knowledge-based model (KBM) assumes that the more influential members are those using knowledge (for further details, see Reimer & Katsikopoulos, 2004, p. 1011).

More specifically, (a) the RBM assumes that the simple majority of those group members who can use the recognition heuristic (i.e., those who recognize one but not the other object and choose the recognized one) determines the group choice, while all others are ignored, including those who have to rely on knowledge. (b) Conversely, according to the KBM, the majority of members who can use knowledge (i.e., those who recognize both objects) determines the group choice, while the opinions of all other members are ignored. Imagine, for example, a three-member group has to infer whether Company A or Company B has a higher market capitalization. Two members may have heard of A before but do not recognize B and thus infer (applying the recognition heuristic) that A has a higher market capitalization. The third member, in contrast, recognizes both names and infers that B has the higher market capitalization based on some knowledge cues. If the group as a whole operates according to the RBM, the group choice would be A, whereas if it operates according to the KBM, it would be B. Note that both models are noncompensatory and predict that just one individual (in the latter case the knowledge-using member) can overturn a majority.

Reimer and Katsikopoulos (2004) empirically tested the models with three-member groups having to infer which of two American cities had the larger population. One of the major results was that, overall, the RBM predicted the observed group choices better than the KBM. This finding is surprising and counterintuitive as it shows that members lacking knowledge can dominate group decisions and trump a majority of members who recognize both objects and are, thus, more knowledgeable. Adhering more often to the RBM than to the KBM in this study was functional, though, because it increased groups' overall performance.

Despite this main finding of recognition dominating group decisions most of the time, in a considerable number of cases, recognition did *not* trump the vote of a majority of group members who could use their knowledge. A closer look at the results of Reimer and Katsikopoulos (2004; see their fig. 3, p. 1019) revealed that there was a similarly large variance in strategy adherence among groups as has elsewhere been found in individuals (Pachur & Hertwig, 2006). Why groups relied on different strategies and whether they behaved adaptively in doing so, however, remained unexplored. We therefore aimed to study differences between groups who predominantly use the RBM and those who predominantly use the KBM and to explore strategy selection by testing the idea that groups select their strategies in an adaptive way. Extending the adaptiveness hypothesis (Pachur, 2011) to the group level, we assumed that groups are more likely to use the RBM than the KBM when the RBM yields more accurate inferences, and vice versa. We next examine the hypothesis that groups, like individuals, adaptively select a strategy from their toolbox in more detail and discuss how time constraints affect the adaptive selection of strategies.

1.3. The adaptive selection of strategies in group decision making

Given the adaptive use of the recognition heuristic in individuals, we aimed to test if groups are also able to select their strategies according to the theoretical accuracy of the RBM and KBM. The theoretical accuracy of the RBM and KBM is informative about how often relying on the person using the recognition heuristic or using knowledge, respectively, will lead to correct inferences (see Table 1). As individual decision makers use the recognition heuristic in particular when recognition is a good predictor (Pachur, 2011), we expected similar findings for groups.

We expected that the quality of a group strategy (i.e., its theoretical accuracy) likely depends on the average quality of individual strategies (here: measured by the recognition or knowledge validity; see Table 1) and/or of choices when decisions that were previously made on an individual level are integrated on the group level (e.g., Hastie, 1986; Laughlin, 1999). For example, groups were well advised to follow the opinions of their most knowledgeable members when these members were more often correct than their less knowledgeable members. We therefore expected that groups with a large number of members with high knowledge validity (or a high average knowledge validity per group) would rely predominantly on the KBM. The opposite was expected for groups with a high average recognition validity. This latter assumption is supported by the study of Reimer and Katsikopoulos (2004), where the great adherence to the RBM was accompanied by a high recognition validity and a low validity of group members' knowledge in every single group (on average .81 vs. .58, respectively).[1]

In sum, the major goals of this study were to find out if groups apply the KBM and RBM in an adaptive way and if the use of the two different strategies is accompanied by a certain group composition in terms of the knowledge and recognition validity. At the same time, we explored *how* groups might actually select strategies adaptively. Here, it would be most adaptive if members with high recognition or knowledge validities had the strongest impact on the group decisions, respectively. Yet recognition and knowledge validities are most likely not directly accessible by individuals, so they have to be inferred based on cues (Pachur, 2011). Potential cues include how quickly objects are recognized, how much other knowledge can be retrieved from memory, or how trustworthy the source of recognition is thought to be.

1.3.1. How is strategy use reflected in discussion behavior?

An advantage of studying simple heuristics in a group setting is that people are urged to verbalize their strategies and reasons, making them easily observable. Although we cannot expect that verbalized reasoning exactly mirrors the strategies actually used (as those might not be accessible to people; e.g., Nisbett & Wilson, 1977), the process may still reveal participants' subjective, important reasons and provide a source for new insights for researchers (see Keller, Gummerum, Canz, Gigerenzer, & Takezawa, 2013; for a similar claim). This may help to address the question of whether people really *use* the recognition heuristic (Hilbig, 2010), that is, whether they rely on their recognition when the recognition heuristic models their choices best. Translated to the group level, the question is whether the recognition cue is a behavioral correlate of the RBM and thus more often used during discussion by groups that predominantly use the RBM than by groups that predominantly use the KBM. Thus, we measured the frequency with which the recognition cue was mentioned during discussion and also whether the recognition cue was perceived as a particularly valid argument compared to other pieces of information to test the hypothesis that the recognition cue is more frequently used by RBM than by KBM groups.

Another behavioral indicator of why groups predominantly adopt proposals by particular members can be derived by analyzing who speaks first when facing a new task. Previous studies have revealed that members speaking very early in a group discussion are more likely to exert influence than members speaking later (Abele, Stasser, & Groebe, 2012; Anderson & Kilduff, 2009; Hoffman, 1978; Shaw, 1961; Stasser, 2012). Therefore, we coded whether the member who could rely on the recognition heuristic or the member who had to rely on further knowledge spoke first and hypothesized that in RBM groups, the member using the recognition heuristic would more often contribute very early, whereas in KBM groups, this should be the knowledge-using member.

1.3.2. Do time constraints affect strategy use and discussion behavior?

Previous research on individual decision making has shown that time constraints have an impact on the extent to which different strategies are adaptive and on which strategies are used (e.g., Christensen-Szalanski, 1978, 1980; Marewski & Schooler, 2011; Pachur & Hertwig, 2006; Payne, Bettman, & Johnson, 1988, 1993; Rieskamp & Hoffrage, 2008; Svenson, Edland, & Slovic, 1990; Zakay, 1985). From group research and the attentional focus model (Karau & Kelly, 1992), we know that time constraints urge groups to focus on fewer and more valid cues (Kelly & Loving, 2004). Because of its retrieval primacy, recognition should become such a particularly valid cue. We thus included two time conditions (with and without time constraints) to explore the following assumptions. Time constraints should foster the use of the RBM as this model involves only one type of argument, the recognition heuristic, and should thus be a less time-consuming strategy than the KBM, which requires an exchange of arguments for each alternative. At the behavioral level, we expected to find an increased use of the recognition cue by RBM groups when they were under time constraints than when they were not, as a sign of it being a particularly diagnostic cue for them.

1.4. Overview of research questions

In sum, we aimed to test whether groups selected their strategies in an adaptive way, that is, whether groups integrated their individual opinions with a strategy that led to the highest achievable accuracy and was contingent on their specific composition in terms of task-relevant features (here: the recognition and knowledge validities). Moreover, we investigated whether time constraints affected the use of these strategies as opposed to no time constraints. Finally, to identify potential mechanisms behind adaptive strategy selection, we assessed behavioral correlates of the two decision strategies, which has rarely been done in previous research but is often asked for in the literature (Baumeister, Vohs, & Funder, 2007; Scholl, 2007).

2. Method

2.1. Participants and design

One hundred thirty-two students (86 female, 46 male) from the Humboldt University of Berlin, Germany, participated in the study that was part of a larger study on decision making. Their age ranged from 20 to 57 years with a mean age of 26.11 years (SD = 5.7). The three-member groups (n = 44) were randomly assigned to one of the two time conditions (with vs. without time constraints). Participants received performance-contingent payment for their participation contingent on their group performance in the economic comparison task [with an average compensation of about €17 ($26)]. One group had to be excluded from the analyses because of incomplete recording of individual answers. Thus, the final sample consisted of 43 groups (23 groups in the condition with time constraints and 20 groups in the condition without time constraints).

2.2. *Procedure*

Upon arrival, participants were randomly assigned to one of the time conditions and to a three-member group. The experiment consisted of three parts, which lasted altogether approximately 1.5 h. All tasks were administered through a personal computer. In the first part, participants individually completed a recognition test in which they were asked to indicate which of the 100 company names they recognized. The names were presented on a computer screen in random order and answers had to be indicated by pressing one of two keys (*recognition* or *no recognition*). Then, the economic comparison task (see Experimental task) was administered individually. It contained 50 comparison pairs, being the same for the three participants who constituted a group in the second part, but not across groups.

For the second—the group—part, participants were asked to sit around a table facing a computer screen and a camera. Group members were instructed to come to joint decisions for the same 50 pairs of the individual paired-comparison task. They were asked to take turns typing the joint decision in a clockwise fashion so that no group member would play the role of a moderator or leader. Moreover, they were told that it was not possible to correct the decision after it was made and that they would not be given any feedback about the correctness of their answers until the end of the experiment. Finally, to increase their motivation, participants were informed that they would receive exclusively performance-contingent payment, namely, that each correct group decision would earn €0.50 ($0.78) for each person and that each member of a group would receive the same amount of money at the end of the experiment.

In the condition with time constraints, we restricted the discussion time of each comparison pair to 30 s in total. The time a group had to reach a decision was visualized by a countdown on the screen above the pair. The time between having answered one pair and releasing the next one (by pressing the space bar) was not restricted. Groups in the condition without time constraints were told that they could take the time they needed for their discussion.

In the third part, participants were asked to individually answer demographic questions and a manipulation check item: "I felt time pressure during the discussion" (answered on a scale from 1 = *I totally disagree* to 5 = *I totally agree*). Answers indicated that the respective time condition was successfully manipulated, $M_{\text{without time constraints}} = 1.30$, $SD = 0.58$ versus $M_{\text{with time constraints}} = 3.56$, $SD = 1.18$; $t(117) = 12.78$, $p < .001$,

d = 2.44. Last, they completed the *argument recall task*, which asked, "Which important arguments stated during discussion that spoke for or against a high market capitalization of a company do you recall? Please write down the four most important arguments speaking for a high market capitalization and the four most important ones that speak against it. Please rank them according to their importance (high scores indicate great importance)." Note that this recall task referred only to cues used as arguments and (in retrospect) to the complete discussion. Upon completion of the individual questionnaires, participants were debriefed, paid, thanked, and released.

2.3. The paired-comparison task

In the economic comparison task, two German company names were presented and the one with the higher market capitalization had to be selected (task adapted from Marewski & Schooler, 2011; Experiment 5). The market capitalization reflects the current total value of a company and equates to the price a purchaser would have to pay for a full takeover (Glossary of Deutsche Börse Group, n.d.). Similar to the population-comparison task used by Reimer and Katsikopoulos (2004), this is a magnitude-inference task with characteristics of a judgmental task (see Introduction). The correctness of answers was evaluated according to the market capitalization of the companies as of the month preceding the study. The term *market capitalization* was explained to the participants as defined above.

A sample of 100 company names, ranging from hardly to widely recognized, was selected from the 130 companies that were listed on the three major German stock exchanges in 2008 (DAX, MDAX, and SDAX).[2] On the basis of individual recognition test results, the 100 companies were randomly paired with each other once for each group separately for the group paired-comparison task. The only restriction for the pairing was that the chance of obtaining pairs in which both the RBM *and* the KBM were applicable and differed in their predictions for the group choices (critical pairs) was maximized.[3] The resulting 50 pairs did not contain any company name twice. The two company names appeared simultaneously and in random position on the screen.

2.4. Dependent measures

All dependent variables are briefly explained in Table 1. From the answers to the two individual tasks (the recognition task and the paired comparisons), the dependent variables recognition and knowledge validity were calculated. To evaluate how well each decision model explained the group inferences, the proportion of trials in which the predictions of a model and the actual group choice converged was calculated (predictive accuracy). Moreover, we computed the proportion of trials in which the models would choose the company with the higher market capitalization (theoretical accuracy) and the proportion of trials in which a group chose the company with the higher market capitalization (achieved accuracy or performance).

To explore how groups implemented their decision strategy, we analyzed the videotaped discussions and the answers to the argument recall task. The frequency of cues mentioned during discussion was determined on the basis of the Discussion Coding System (DCS; Schermuly & Scholl, 2011, 2012).[4] The general procedure of the DCS is to divide the interaction process into acts, which can be a sentence or several sentences of the same topic, and then to code the functional and interpersonal meaning and content of each act. The content of an act was coded into two main categories: (1) An act was coded as a *recognition cue* when a person used the recognition heuristic as an argument or simply let the other members know that she/he recognized one company name but not the other. It was also coded when a person used the recognition cue of another member or the whole group as an argument. Example statements are, “If you do not even recognize company A, it cannot be big,” and “Let’s take company A, since we all recognize it.” (2) Acts were coded as *knowledge cues* when a group member provided cues about a company other than recognition. Again we did not differentiate between cases in which a person simply stated his/her cue knowledge (e.g., “I know that company B produces drugs”) or used a cue as an argument for or against a high market capitalization (e.g., “Company A is a bank, and banks have money”). Note that Category 2 is wider than Category 1 as it contains different kinds of cues. To evaluate the answers to the *argument recall task*, all (pro and con) arguments that included “(no) recognition” or “(no) renown” were coded as *recognition cues* together with their ranking (0 = *not mentioned*, 1 = *lowest rank*, 4 = *highest rank*).

3. Results

3.1. Individual condition

In their individual condition, participants recognized on average 46 of 100 companies (*SD* = 11.99; range 22–84) and were correct in 60.9% of the 50 inferences (*SD* = 8.4, min = 40%, max = 82%). Confronted with pairs where they recognized both companies, they made 66.2% correct inferences (*SD* = 15.5); that is, their average knowledge validity was .66. With pairs where they recognized neither company, they had an average guessing accuracy of 49.4% (*SD* = 13.5). Finally, with pairs where they recognized just one company (and could potentially apply the recognition heuristic), they made 71.5% correct inferences (*SD* = 14.7). Their average recognition validity, which is the accuracy in pairs in which the recognized object was actually chosen over the unrecognized one, was .69. Thus, in contrast to the study of Reimer and Katsikopoulos (2004), the average recognition and knowledge validities were very similar to each other in this study. On average, participants individually adhered to the recognition heuristic in 83.0% (*SD* = 12.8) of situations in which it was applicable.

3.2. Group condition

All groups together accomplished 43 × 50 = 2,150 inferences. On average, groups answered 66.4% (*SD* = 9.4, min = 44%, max = 84%) of all choices correctly. We first tested whether the two time conditions had an impact on the predictive accuracies of the RBM and KBM. There were no differences regarding the predictive accuracies of the RBM and KBM between the time conditions, respectively, neither for the RBM: $t(41) = 0.003$, $p = .997$, $d = 0.001$, nor for the KBM: $t(41) = 0.82$, $p = .42$, $d = 0.25$.[5] Therefore, the subsequent analyses concerning strategy use are based on the joint data set from both time conditions, consisting of 43 groups or 2,150 comparison pairs.

We next analyzed how often each strategy was applicable, and how often the groups' choices were in accordance with each strategy. The simple majority rule (SM) was applicable to all 2,150 cases and 74.6% of its predictions matched the group choices. Note that, as did Reimer and Katsikopoulos (2004), we will focus on the RBM and KBM rather than the SM subsequently, as they and their correlates will be more informative regarding adaptive strategy selection. The RBM was applicable to 1,243 cases (57.8%) and 74.7% of its predictions agreed with the group choices. The KBM could be applied to 1,015 cases (47.1%), and 80.6% of its predictions agreed with the group choices.[6] The higher overall predictive accuracy of the KBM was functional because its overall theoretical accuracy was higher (72.9%) than that of the RBM (70.8%). As a first hint of adaptive strategy selection, the overall predictive accuracy of the KBM (RBM) on the group level was positively correlated with the theoretical accuracy of the KBM (RBM), $r_{KBM}(41) = .23$, $p = .13$, $n = 43$; $r_{RBM}(41) = .39$, $p = .01$, $n = 43$. That is, groups for whom a strategy yielded more accurate inferences also tended to adhere to that strategy more often, which held particularly true for the RBM.

Because the two subsamples in which the RBM and KBM were applicable only overlapped partially, we then considered the subset of situations where both restricted majority models were applicable ($n = 811$). Here, 81.0% of the predictions made by the KBM and 74.4% of those made by the RBM agreed with the group choices. Again, the theoretical accuracy of the KBM was higher (73.4%) than that of the RBM (71.9%; for correlations see below). An analysis of the 181 situations in which the two restricted majority rules made contrasting predictions (critical pairs) showed that the KBM matched the group choices in 115 situations (64%), and the RBM in 66 (36%). In sum, aggregate analyses suggested a higher predictive accuracy of the KBM overall, together with a higher theoretical accuracy of the KBM. If not stated otherwise, the following analyses were based on the subset of 811 situations in which both models could be applied.

3.2.1. Classification of groups as RBM or KBM groups

Fig. 1 depicts the predictive accuracies of the two strategies for each individual group, ordered according to the predictive accuracy of the RBM. It shows that the overall differences between the predictive accuracies of the KBM and RBM per group are not negligible but range between 3.7 and 50 percentage points ($M = 14.5$, $SD = 8.9$). The large variance of the predictive accuracies of the KBM and RBM suggests differences in strategy use between groups. As with individuals, different groups obviously preferred different strategies and differed in the extent to which they adhered to one of the two strategies.

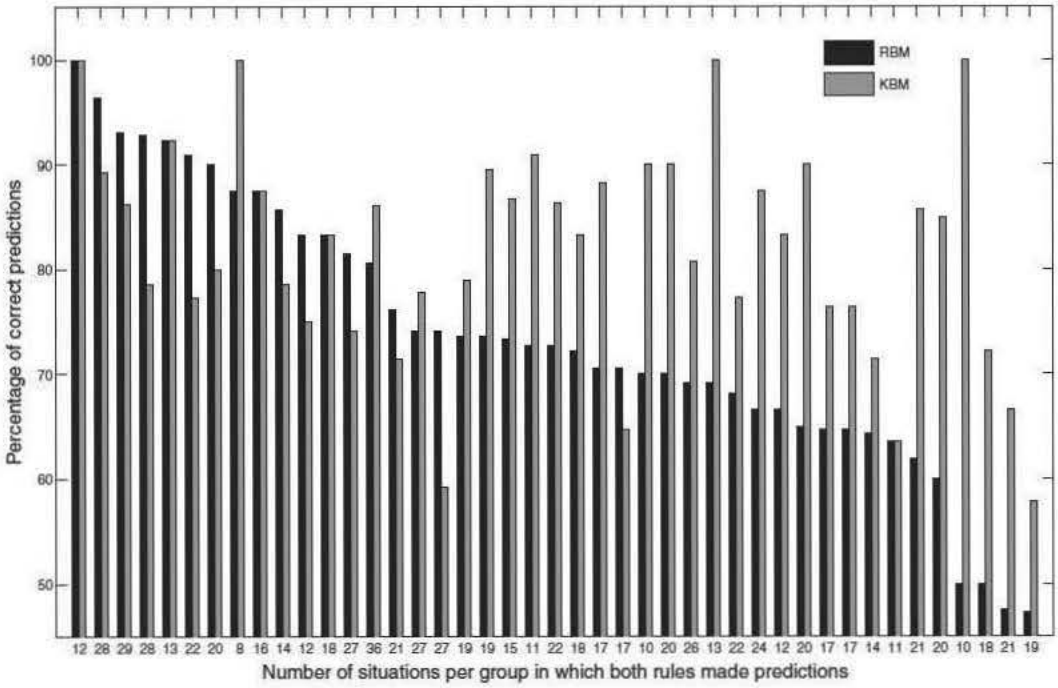

Fig. 1. Percentage of correct predictions by the knowledge based model (KBM) and the recognition based model (RBM), for each group (bars indicate the percentage of situations in which the KBM and RBM made correct predictions for the group choices). Groups are sorted in descending order according to the predictive accuracy of the RBM. Along the *x* axis, the total number of situations per group in which both models, the KBM and the RBM, made predictions is displayed (overall n 811).

To test the adaptiveness hypothesis, our next step was to classify the groups. Several studies on heuristic decision making have argued that systematic individual differences in decision strategies are rather the rule than the exception, and thus, only analyses that take the individual as the unit of analysis allow for a proper assessment of the underlying processes of cognitive strategies (e.g., Gigerenzer & Goldstein, 2011; Marewski, Schooler, & Gigerenzer, 2010; Pachur, Bröder, & Marewski, 2008). Thus, in addition to comparing mean values, we conducted analyses on the level of single groups by classifying each group as an RBM group when more of its choices were matched by the predictions of the RBM than those of the KBM (i.e., if the predictive accuracy of the RBM was higher than that of the KBM) and vice versa (for a similar classification procedure used for individual decision makers see, for example, Bröder & Schiffer, 2006; see also Marewski, Schooler et al., 2010). Note that the resulting classification is supposed to highlight general tendencies in using one strategy more often than a competing one but does not necessarily mean that one single strategy was used consistently throughout. As visible in Fig. 1, the group choices of 27 groups could be best explained by the KBM with a mean predictive accuracy of 83.7%, as opposed to a mean predictive accuracy of 66.9% of the

RBM, paired $t(26) = 9.19$, $p < .001$, $dz = 1.77$. We classified these groups as KBM groups. Conversely, the data of 11 groups could be best explained by RBM with a mean predictive accuracy of 85.0%, as opposed to a mean predictive accuracy of 75.9% of the KBM, paired $t(10) = 8.52$, $p < .001$, $dz = 2.56$. We classified those groups as RBM groups. The data of five groups could be equally well described by both models (with a mean predictive accuracy of 85.4%). These five groups were excluded from further analyses, so that the following results are based on the 38 classified groups.[7] Table 2 summarizes all key differences between RBM and KBM groups reported so far and subsequently.

3.2.2. Was the strategy choice of groups adaptive?

To test the assumption that groups behaved adaptively (i.e., predominantly relied on the strategy that yielded the higher accuracy), we analyzed the theoretical accuracies of the two models for KBM and RBM groups. We first conducted a second classification of all groups based on the theoretical accuracies of the two models. As with the predictive accuracies, the analysis compared the theoretical accuracies of the two models for each group and classified a group as a *t*-RBM group (*t*-KBM group) if the theoretical accuracy of the RBM (KBM) was higher. Fig. 2 depicts the theoretical accuracy of the two strategies

Table 2
Key differences between RBM groups and KBM groups, summarized across time conditions (means, with SDs in parentheses)

	RBM Groups	KBM Groups
N	11	27
Predictive accuracy of the RBM[a]	85.0% (8.6)	66.9% (9.5)
Predictive accuracy of the KBM[a]	75.9% (8.6)	83.7% (9.8)
Theoretical accuracy of the RBM[a]	78.8% (8.1)	67.3% (7.4)
Theoretical accuracy of the KBM[a]	71.8% (9.9)	72.0% (11.6)
Achieved group accuracy[a]	80.3% (9.7)	73.7% (12.3)
Individual recognition validity[b]	.74 (.13)	.66 (.13)
Individual knowledge validity[b]	.66 (.12)	.67 (.15)
Individual speed of recognizing a company (in msec)[b]	1,551 (408)	1,803 (623)
Individual speed of *not* recognizing a company (in msec)[b]	1,556 (376)	1,738 (668)
Individual accordance with recognition heuristic when it led to		
A correct choice[b]	93.6% (11.9)	91.0% (15.7)
An incorrect choice[b]	88.4% (19.9)	86.8% (22.9)
Group accordance with recognition heuristic when it led to		
A correct choice[a]	91.1% (7.3)	80.1% (15.5)
An incorrect choice[a]	59.5% (19.8)	38.9% (15.1)
Relative frequency of speaking first of		
Member using the recognition heuristic[a]	53.4% (17.0)	45.1% (17.3)
Member using knowledge[a]	34.7% (17.4)	49.2% (17.8)

KBM, knowledge based model; RBM, recognition based model; SD, standard deviation.
[a]Based on the 811 pairs where strategies made different predictions.
[b]Based on the individual recognition test.

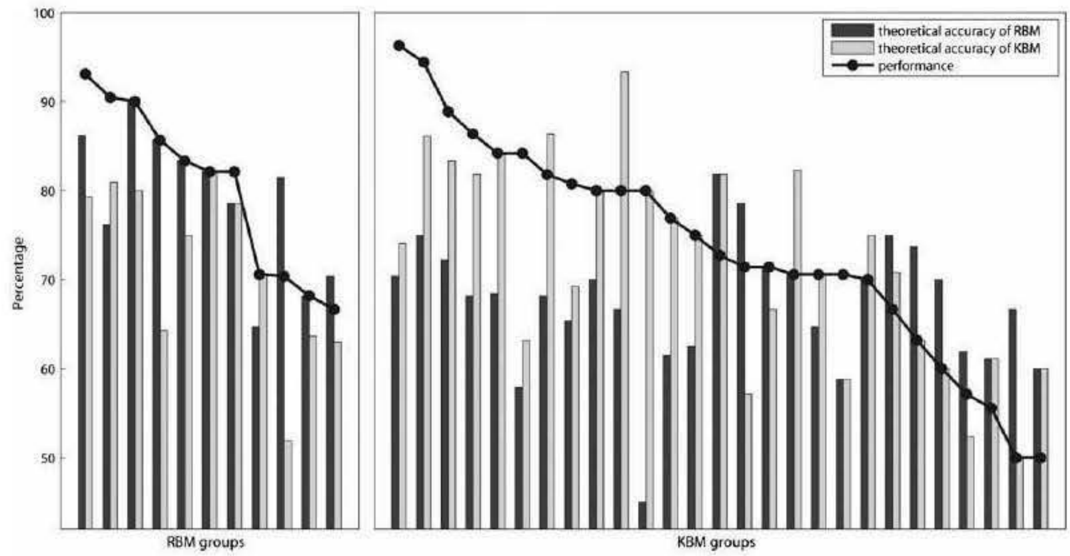

Fig. 2. Achieved accuracy and theoretical accuracy of the KBM and of the RBM for each of the 38 catego rized groups in the subset of situations in which both models were applicable (n 811). The graph displays the values of RBM groups on the left and those of KBM groups on the right. Within these categories, groups are sorted according to their achieved accuracy in descending order. It can be seen that for RBM groups, the theoretical accuracy of the RBM was higher and closer to the observed performance than the theoretical accuracy of the KBM, and vice versa for KBM groups.

for each group (and also the achieved accuracy, to which we refer in the next section). As expected, the theoretical accuracies differed between groups, which suggests that different strategies were adaptive for different groups: Of the 38 groups, 18 were classified as t-KBM groups (for whom the theoretical accuracy of the KBM was on average 12.0 percentage points higher than that of the RBM) and 14 as t-RBM groups (for whom the theoretical accuracy of the RBM was on average 11.8 percentage points higher than that of the KBM). For six groups, the theoretical accuracies were identical.

If strategy selection were adaptive, the classification of groups based on predictive accuracy (i.e., their choices) should be similar to the classification based on the theoretical accuracy of the strategies. If we look at those 32 groups for which the theoretical accuracies allowed a classification, we find a convergent classification rate of 71.9% (23 of 32) with the classification based on the predictive accuracies. Moreover, the theoretical accuracy of the KBM (RBM) was positively correlated with the predictive accuracy of the KBM (RBM) on the group level, $r_{KBM}(36) = .39$, $p = .02$, $n = 38$; $r_{RBM}(36) = .48$, $p = .003$, $n = 38$.

Adaptive behavior should be mirrored by a high performance level. To look into this aspect, we compared the achieved accuracy per group with the accuracy that would have been achievable if groups had consistently used one of the two decision strategies (i.e., their theoretical accuracies; see Fig. 2). On average, we observed a mean achieved accuracy of 80.3% for the 11 RBM groups. The mean theoretical accuracy of the RBM for RBM groups was 78.8% and of the KBM only 71.8%, paired $t(10) = 2.19$, $p = .05$, $dz = 0.37$. The 27 KBM groups made fewer correct choices in the subset than RBM groups, namely, 73.7%, on average.[8] The mean theoretical accuracy of the KBM for KBM groups was 72.0% and of the RBM only 67.3%, paired $t(26) = 1.94$, $p = .06$, $dz = 0.66$. Thus, as the classification of the groups on the basis of the theoretical accuracies had already suggested, these results support the conclusion that groups chose their strategies in a majority of trials in an adaptive way by picking the strategy that yielded the higher accuracy.

3.2.3. Adaptation on individual trials within groups

It is a simplifying assumption that groups use one strategy consistently, but it is necessary for the classification and to derive conclusions about differences between groups. Nevertheless, it is of course possible that groups also adapt their strategy to individual trials. An interesting measure of strategy adaptation on the trial level is to distinguish cases in which the recognition heuristic leads to a correct decision and those where it leads to an incorrect decision (the difference of these two proportions is termed the discrimination index; see Hilbig & Pohl, 2008). Members of RBM and KBM groups both *individually* accorded with the recognition heuristic to a similar degree when it led to a correct decision as when it led to an incorrect decision [see Table 2; RBM-group members: paired $t(29) = 1.45$, $p = .16$, $dz = 0.26$; KBM-group members: paired $t(63) = 1.30$, $p = .20$, $dz = 0.16$]. Groups, in contrast, showed a more selective accordance with the recognition heuristic and accorded with it more often when it led to a correct decision than when it led to an incorrect decision, and this was more strongly the case for KBM groups than for RBM groups [see Table 2; KBM groups: paired $t(26) = 8.66$, $p < .001$, $dz = 2.03$; RBM groups: paired $t(10) = 5.12$, $p < .001$, $dz = 1.54$]. Thus, both RBM and KBM groups showed a more selective accordance with the recognition heuristic than individuals, indicating that groups incorporate information beyond recognition more strongly than individuals. Congruent with the classification of groups as RBM or KBM, the selectivity of accordance was much less pronounced in RBM groups than in KBM groups: Only RBM groups less selectively accorded with the recognition heuristic both when it led to a correct as well as when it led to an incorrect decision in the majority of their choices (i.e., >50%), which was not true for KBM groups.

3.2.4. Mechanisms behind adaptive strategy use

One determinant of the quality of group strategies (i.e., their theoretical accuracy) might be the quality of individual members' strategies and choices (i.e., the knowledge and recognition validity). In fact, the theoretical accuracy of the KBM was highly correlated with the average knowledge validity of the members of a group, $r(36) = .65$, $p < .001$, $n = 38$; similarly, the theoretical accuracy of the RBM was highly correlated with the average recognition validity of the members of a group, $r(36) = .74$, $p < .001$, $n = 38$. Interestingly, in RBM groups, the members' average recognition validity ($M = .74$, $SD = .13$) was considerably higher than their knowledge validity ($M = .66$, $SD = .12$), as in the study by Reimer and Katsikopoulos (2004; in particular in the unselected sample, see note[1]). Conversely, in KBM groups, the average recognition (M = .66, SD = .13) and knowledge (M = .67, SD = .15) validity were very similar to each other.

One possible cue to one's knowledge and recognition validities is one's recognition time (Pachur, 2011). An analysis of variance (ANOVA) with repeated measurements with the individual recognition judgment (recognized vs. not recognized) as the within-subject factor and the type of group as the between-subjects factor revealed that RBM-group members had indeed faster recognition times than KBM-group members (see Table 2), $F_{\text{group type}}(1, 112) = 3.59$, $p = .06$, $\eta_p^2 = .03$. Thus, RBM-group members may have inferred their higher recognition validity from their faster recognition times.

3.2.5. *Behavioral correlates of RBM and KBM*

Did RBM groups differ in their group discussions from KBM groups? We first focused on the very first act of the discussion concerning each trial. Independent of the content of the first argument, we coded who spoke first. Did members who could rely on the recognition heuristic predominantly speak first in RBM groups, and did members who could rely on knowledge do so in KBM groups? We entered the two relative frequencies of members using the recognition heuristic and speaking first and of members using knowledge and speaking first per group into a mixed ANOVA with member type as within-subject factor. Between-subject factors were the group type and the time condition. It revealed an interaction effect, namely, that, in fact, members who could rely on the recognition heuristic spoke first slightly more frequently in RBM groups (M = 53.4%, SD = 17.0) than in KBM groups (M = 45.1%, SD = 17.3), whereas those members who could rely on knowledge spoke first more often in KBM groups (M = 49.2%, SD = 17.8) than in RBM groups (M = 34.7%, SD = 17.4), $F_{\text{Group Type} \times \text{Member Type}}(1, 34) = 4.31$, $p = .05$, $\eta_p^2 = .11$. No main effects were revealed.[9] Speaking first thus nicely mirrored the group strategy on the behavioral level.

We then analyzed the arguments exchanged during the decision process. Did RBM groups mention the recognition cue more often than KBM groups in general, for example, because it was a more valid cue for them (cf. Littlepage, Perdue, & Fuller, 2012)? And did RBM groups under time constraints mention the recognition cue more often than RBM groups without time constraints? First, we computed the average joint number of all recognition and knowledge cues that were exchanged per trial (within the subsample of 811 trials). We then entered this number into an ANOVA with the two time conditions and two group types as independent variables. No difference was revealed between the group types, $F_{\text{group type}}(1, 34) = 1.00$, $p = .33$, $\eta_p^2 = .03$, but—quite naturally—there was a difference between the time conditions: Groups with time constraints discussed fewer cues (M = 2.39, SD = 0.77) than groups without time constraints (M = 3.97, SD = 1.79), $F_{\text{time}}(1, 34) = 7.12$, $p = .01$, $\eta_p^2 = .17$. Next, we computed the relative frequency of the recognition cue with regard to all cues and took this as the dependent variable in a second ANOVA. It revealed a main effect of time, namely, that the relative frequency of the recognition cue in groups with time constraints was higher (M = 14.3%, SD = 8.1) than in groups without time constraints (M = 9.4%, SD = 5.6), $F_{\text{time}}(1, 34) = 10.56$, $p = .003$,

$\eta_p^2 = .24$; in other words, groups exchanged a greater proportion of knowledge cues when they had time. More interestingly and as expected, it revealed that RBM groups under time constraints mentioned the recognition cue more often ($M = 20.3\%$, $SD = 7.4$) than RBM groups without time constraints ($M = 6.36\%$, $SD = 3.24$) and KBM groups in both time conditions ($M_{\text{with time constraints}} = 10.7\%$, $SD = 6.4$; $M_{\text{without time constraints}} = 10.4\%$, $SD = 5.8$), $F_{\text{Time} \times \text{Group Type}}(1, 34) = 9.51$, $p = .004$, $\eta_p^2 = .22$.

The results of the *argument recall task* show a similar picture. Recall that every participant was asked to name arguments' pro *and* con, so that the recognition cue (recognition or no recognition) could be named zero times, once, or twice per person. For the following analyses, we counted the number of people who recalled the recognition cue at least once and found that 25 of 33 RBM-group members (75.8%) and 59 of 81 KBM-group members (72.8%) did so. We then analyzed the two votes these people gave and report in Fig. 3 the percentages of times the recognition cue was not mentioned (0) and rated as low (1) to high (4) importance by people who recalled the recognition cue at least once. It shows that in the condition without time constraints, the recognition cue was ranked more often as of high importance by RBM-group members and was more often not mentioned by KBM-group members. In the condition with time constraints, more RBM-group than KBM-group members rated the recognition cue as of moderately high (3) and high

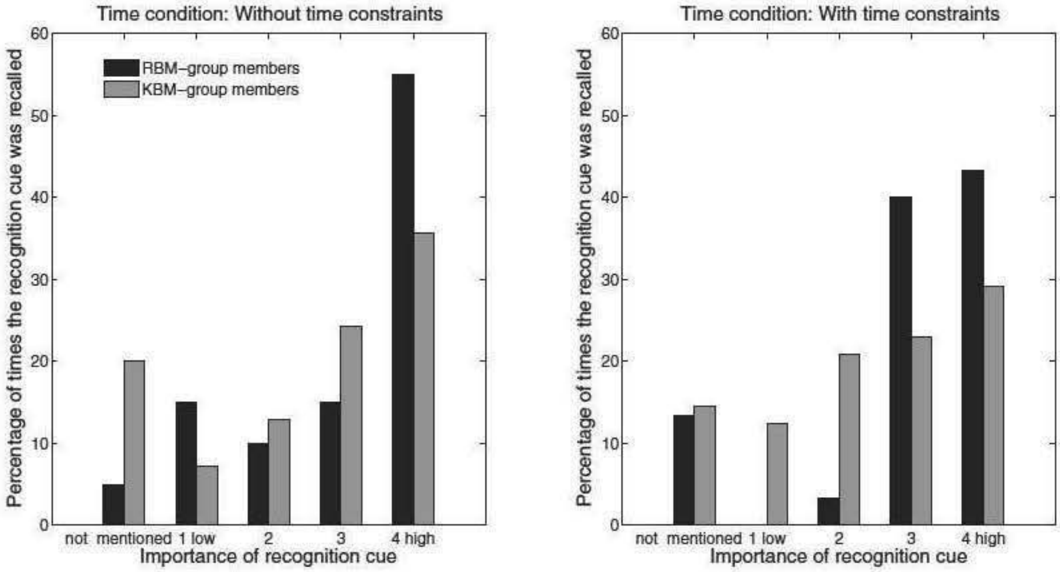

Fig. 3. Percentage of times the recognition cue was recalled by participants who mentioned it at least once in the argument recall task (*n* 84) and assigned a particular importance rating, on the left for the condition without time constraints (*n* 45) and on the right for the condition with time constraints (*n* 39). Note that every participant had two votes and could thus recall the recognition cue zero times, once, or twice; the total number of which the percentages are reported here is therefore 84 × 2 168 times the recognition cue could possibly be mentioned.

(4) importance, whereas the reverse was true for the low (1) and moderately low (2) importance ratings. To summarize, the observed frequency and importance ratings of the recognition cue indicate that the recognition cue constitutes a behavioral correlate of the RBM and was perceived as a valid cue, in particular under time constraints.

4. Discussion

In many instances in everyday life as well as in organizations, decisions are made by groups (Salas et al., 2008). Here, we applied the framework of ecological rationality to investigate an important aspect of group decision making: Are groups able to select strategies adaptively? From this perspective, transferred from the individual to the group level, the success of a decision strategy is anchored both in the structure of the task environment and in the composition of the individual minds of the group. We focused on the second aspect, that is, on if and how groups adapted their strategy to group composition.

4.1. Summary of results

To this end, we studied two particular decision strategies: one restricted majority rule that assumes that only the votes of group members who can rely on knowledge determine the group decision (the KBM); and another that assumes that only the votes of group members who can rely on the recognition heuristic are taken into account (the RBM). Our main goal was to test if groups select these two strategies in an adaptive way in a paired-comparison task. Adaptivity was defined as the degree to which the strategy was applied in the majority of trials that also yielded the more accurate inferences. In fact, we found that the choices of most groups were best predicted by the strategy that also led to the highest theoretical accuracy. Therefore, groups, on average, achieved a performance level that was close to the best they could achieve theoretically (see Fig. 2).

In addition to exploring the general question of adaptive strategy selection, we tested the effect of time constraints on strategy use. Contrary to our expectations, we did not find that time constraints led to an increased use of the RBM (i.e., no difference in predictive accuracy of the RBM between time conditions). The rationale behind our assumption was that the RBM would require fewer arguments than the KBM, rendering it a faster and more frugal strategy. No differences in the total number of arguments, however, were found between groups who predominantly relied on one or the other strategy. Consequently, at first glance, this result seems to contradict findings in individual decision strategy research showing that the use of noncompensatory decision rules increases with decreasing time available (e.g., Christensen-Szalanski, 1980; Pachur & Hertwig, 2006; Svenson et al., 1990; Zakay, 1985). On closer inspection, however, this result is plausible for two reasons. First, on the group level, one can regard both the RBM and the KBM as noncompensatory strategies, in that a minority of group members can trump a majority. Second and more important, the lack of difference in predictive accuracies of the RBM and KBM supports the adaptiveness findings, as the KBM and RBM did not differ in their theoretical accuracies between the time conditions in the first place (see note[5]). In other words, the RBM would not have been more adaptive under time constraints. Time constraints in the group phase may not have influenced decision strategies because opinion formation had already taken place individually, before the group discussion, and there were no time constraints in this individual phase of the experiment. It would be an interesting question for future research to test whether time pressure faced by individuals who make a decision prior to meeting in a group has an impact on the group strategy.

Interestingly, we found an effect of time constraints on discussion behavior, namely, that time constraints led to an increase in the relative frequency of the recognition cue being discussed as compared to knowledge cues by all groups and in particular by RBM groups. This enhancement effect seems to support the assumption that recognition is a very valid cue (Kelly & Loving, 2004) and that it plays a special role in decision making. Ratings of the freely recalled arguments again revealed the higher importance of the recognition cue for RBM groups, as more RBM-group members than KBM-group members mentioned and perceived the recognition cue as highly important. The number and persuasiveness of arguments may cause a group to shift to an alternative that has not been favored by a majority before (Hinsz & Davis, 1984). Despite these supportive differences in the relative frequencies, the absolute numbers reveal that mentions of the recognition cue constituted only a small proportion of all mentioned cues. A technical reason for this finding may be that the categories had different widths: Although the recognition cue was counted only when it was mentioned as such, the knowledge-cues category comprised all cues containing information about the companies at hand, such as a company's sector or products. Another reason might be seen in the justification pressure caused by the group setting, which often leads people to use more information than they initially used in individual decisions (Huber & Seiser, 2001; Lerner & Tetlock, 1999). In sum, we found evidence for the adaptive selection of two strategies in small groups, and that time constraints had no impact on this selection but enhanced the usage of one of the most valid cues, the recognition cue.

As a final behavioral correlate, we assessed who spoke first and found that this was indeed an indicator of the group strategies used, with members classified as knowledge users speaking first more often in KBM groups than recognition users and vice versa in RBM groups. In addition to being a behavioral correlate, speaking first can also be seen as a process measure and a reason why groups end up using one strategy or another (cf. Stasser, 2012). Indeed it has been found elsewhere that the first answers provided have a strong impact on the final group answer (Anderson & Kilduff, 2009). More research is needed to tease apart whether contributing early is only an indicator or a driving force for selecting a certain decision (rule).

4.2. Mechanisms behind adaptive strategy selection

How did group members decide if they should follow those members who could rely on the recognition heuristic in an adaptive way? This question rephrases a question that is also central to the concept of the recognition heuristic as part of the adaptive toolbox for individual decision making. More generally, this fundamental problem of how people decide how to decide is known in the literature as the strategy selection problem, and a number of approaches to strategy selection have been proposed (e.g., Payne et al., 1988, 1993; Rieskamp & Otto, 2006; Scheibehenne, Rieskamp, & Wagenmakers, 2012; for an alternative account, see Newell & Lee, 2011; for a comment, see Cooper, 2000; for a debate, see Glöckner, Betsch, & Schindler, 2010; Marewski, 2010). Note that we do not claim that people have direct access to the theoretical accuracies of different strategies and then consciously decide which one to follow (nor is this an assumption of any of the strategy selection accounts). Rather, we hypothesize that some plausible mechanisms lead groups on a trial-by-trial basis to adopt a certain choice and that this leads them—with regard to the accomplishment of the complete task—to appear to predominantly follow one rule.

In our case, one possible scenario can be outlined as follows: Group members have access to the quality and adaptivity of their recognition and knowledge, which they communicate to the other members, for example, by bringing up important arguments or by the timing of putting forward their arguments (namely, by speaking first; e.g., Anderson & Kilduff, 2009), and by this lead the group decision in a particular direction. How might people access the quality of their recognition?

One hypothesis concerns the role recognition speed (i.e., fluency) might play. As Schooler and Hertwig (2005) argued, recognition speed can be taken as a proxy for the activation of a memory record: “the lower the activation, the more time it takes to retrieve a record” (p. 616). Activation of a memory record is a noisy process. The clearer the activation, the more systematic the image of the world around us should be, and thus the better people should be able to tell a truly recognized from a truly unrecognized object, rendering recognition a diagnostic cue (for the impact of additional knowledge in recognition cases on decision times, see Hilbig & Pohl, 2009). If we now assume that people are sensitive to differences in recognition times and that fluency is often correlated with the criterion (Hertwig, Herzog, Schooler, & Reimer, 2008; Schooler & Hertwig, 2005), it seems plausible that people may (correctly) rely on fluency to infer their recognition accuracy (i.e., validity). So far, this mechanism has been proposed to explain the adaptive use of the recognition heuristic on the level of a single item (item adaptivity) as well as on the level of a particular environment (environment adaptivity) by individual decision makers (Pachur, 2011; Pachur & Hertwig, 2006). We propose that it might also play a role on the group level because fluency is also important in social interactions, because short recognition times elicit high confidence (Zakay & Tuvia, 1998) and indicate certainty (Erdfelder, Küpper-Tetzel, & Mattern, 2011), and because greater confidence makes people more influential in a freely interacting group (Zarnoth & Szniezek, 1997). Indeed, we found that RBM-group members gave slightly faster judgments in the recognition task than KBM-group members, which may have rendered them more confident and thus influential, causing those groups to rely more often on the RBM.

Given that group members often have difficulties correctly judging members’ expertise from confidence and paralinguistic cues (Henry, Strickland, Yorges, & Ladd, 1996), another scenario that builds on the content and quality of arguments might be even more plausible. This scenario could be that the KBM serves as a default strategy, as “more knowledge” (here: recognizing both objects rather than just one) is typically assumed to be better (Chu & Spires, 2003). Similarly, individuals often start out with decision strategies that consider all pieces of information (see, e.g., Bröder & Schiffer, 2006; Kämmer et al., 2013). This would mean that groups pool their available knowledge and follow the most knowledgeable member(s) by default, only following members who can rely on the recognition heuristic (and who thus only recognize one object) if they have strong reasons to do so. An indicator for the plausibility of this default scenario can be seen in the large proportion of KBM groups in our study (27 vs. 11 RBM groups).

There are a number of reasons why groups might deviate from the default rule. For example, the recognition cue might be better than the general knowledge cues of knowledge users because (a) there is a primacy of cognitively inexpensive cues (such as recognition, cf. Pachur & Hertwig, 2006) or (b) the recognition cue is particularly persuasive. According to the probabilistic persuasion theory, argument quality can be measured by a cue’s ecological validity (cf. Reimer, Hertwig, & Sipek, 2012). Thus, the much higher recognition validity as compared to the knowledge validity in RBM groups may be one reason for the greater persuasiveness of the recognition cue in those groups. Note that this difference is still smaller than it was in the groups studied by Reimer and Katsikopoulos (2004), where the average difference between recognition and knowledge validities was as high as 23 percentage points, which could explain why the RBM played a stronger role there. The default scenario explains why the reverse difference between the recognition and knowledge validity would not be a precondition for groups to apply the KBM.

Second, what can also make the recognition cue more persuasive than general knowledge is that knowledge cues do not suggest a direction for the decision (such as when people know that A is a bank and B is a car manufacturer but do not know which sector scores higher on the criterion market capitalization), whereas the recognition heuristic always entails the direction. A third possible reason is based on the assumption that the use of the recognition heuristic involves two distinct processes, namely, judging if an object is recognized and evaluating if recognition is a useful and reliable indicator given the task (see Volz et al., 2006; for evidence of the neural basis of these two processes). People may thus consider, for example, the source of recognition to evaluate the validity of their recognition (see Marewski, Gaissmaier, Schooler, Goldstein, & Gigerenzer, 2009; Pachur, 2011). In the group setting, they may then communicate to the others their evaluation result either directly, by naming the source, or indirectly, through their confidence level or other paralinguistic signals.

Notwithstanding the plausibility of the aforementioned possible scenarios underlying the adaptive use of the RBM and KBM, more research is needed to elaborate on them. Moreover, and because it is most often important to give the appropriate weight to the right people (Einhorn et al., 1977; Hastie, 1986; Steiner, 1972), more research should aim to tease apart the relative power of the different channels of communicating expertise and exerting influence: How much do argument quality and content, confidence, paralinguistic cues, and the timing of the speech count (Littlepage & Mueller, 1997; Littlepage et al., 2012; Littlepage, Schmidt, Whisler, & Frost, 1995)? Are they independent parameters or do they interact with each other?

4.3. Limitations and open questions

This study is of course only a first step toward understanding adaptive strategy selection by groups. Its biggest limitation is its focus on one particular strategy, the recognition heuristic, which is only applicable in a limited set of situations. On the other hand, the heuristic and the tasks to which it can be applied are very well defined, and the heuristic can be applied on the individual level and transferred to the level of groups. These aspects were ideal preconditions for testing adaptive strategy selection on the group level in relation to the composition of groups. This form of adaptivity is certainly just one specific notion of adaptive group decision making that deserves research. Other forms concern, for example, adaptivity with regard to different task environments (Kämmer et al., 2013) and task types (Davis, 1992; Hackman et al., 1976; Littlepage, 1991; Steiner, 1972). It would be important to expand this line of research to a broad range of forms of adaptivity, different models of group decision making, and different tasks.

The underlying assumption of this study is that there are enough similarities between individuals and groups to apply the framework of ecological rationality and the adaptive toolbox (Gigerenzer et al., 1999; Hertwig, Hoffrage, & the ABC Research Group, 2013; Todd, Gigerenzer, & the ABC Research Group, 2012) also on the group level. Of course, the inference of individual–group similarity is an empirical question (Hinsz et al., 1997). More research is needed to work out differences and parallels between individuals and groups that affect the adaptive use of heuristics.

4.4. Implications

The study demonstrates that the framework of ecological rationality is fruitful to study adaptive strategy selection in groups. As Pachur et al. (2008) concluded, individual differences in cognitive strategies appear to be the rule rather than the exception (see also Gigerenzer & Goldstein, 2011). This is transferable to groups as well. By focusing on the group level and intergroup differences as an addition to aggregate analyses, the current study contributes to a more “ideographic” type of research as opposed to more “nomothetic” research, which focuses on identifying general laws of information processing. With the attempt to capture dependencies between decision strategies and group structures, the current study fits to the adaptive toolbox approach and extends it to the group level. It also demonstrates that group research can benefit from formal model testing, as it allows researchers to empirically test different models on a trial-by-trial basis and to derive quantitative evaluations of competing models.

In this way, it links to (a) team composition research, which focuses on the impact of team composition in terms of surface (i.e., overt demographic characteristics) as well as deep-level (such as personality traits or general mental ability) attributes on processes and team effectiveness, especially in an organizational context (e.g., Bell, 2007; Guzzo &

Dickson, 1996); (b) social decision scheme research (Davis, 1973), which investigates the appropriateness of decision strategies for different task types (e.g., Hackman et al., 1976; Ladbury & Hinsz, 2009; Laughlin & Ellis, 1986; Shiflett, 1972; Stone, 1971); and (c) research that tries to connect social decision scheme literature with social influence literature by studying the interplay between member resources, social decision schemes, and interaction processes and their relation to team performance (e.g., Bottger & Yetton, 1988; Einhorn et al., 1977; Yetton & Bottger, 1982).

The study also contributes to research on fast and frugal heuristics. It revealed that an overall highly predictive accuracy of the recognition heuristic for individual choices (here 83%) does not necessarily lead to a highly predictive accuracy of the RBM for group decisions (overall 74%)—but only for those with a high group recognition validity (which was .74 in RBM groups, vs. .66 in KBM groups; the predictive accuracy of the RBM in RBM groups was 85%). Groups may be more sensitive to detecting how strongly someone believes in the recognition argument. Although on an individual level there is little else one can do but apply the recognition heuristic, on the group level there is the question of whether to mention (non-)recognition or not. Furthermore, in contrast to individuals, groups have the chance to gather information about both objects even if one object is not recognized by some, whereas an individual does not have access to information about the unrecognized object. Thus, on the basis of the information collected during the group discussion, it might be more reasonable and successful to decide for the previously unrecognized object if more arguments (or people) are in favor of it. Still, we argue that studying how people perform the same task as individuals and in groups can help illuminate how heuristic strategies are used (see also Reimer, Hoffrage, & Katsikopoulos, 2007). Of more theoretical importance and relevance for the debate on the role recognition plays in decision making (e.g., Hilbig, 2010) is our finding that recognition was verbalized and used as an argument during discussion and was perceived as a highly valid piece of information.

Finding a number of groups predominantly relying on their members using only recognition information (RBM groups) and that these groups performed very well (and even better than KBM groups) can be seen as another piece of evidence that, under certain conditions, groups may gain from limiting the amount of information and bet on less knowledgeable members. This result is of great practical importance, given the often observed difficulty that groups face when pooling and integrating many pieces of information (Reimer, Reimer, & Czienskowski, 2010; Reimer, Reimer, & Hinsz, 2010; Stasser & Titus, 2003; Tindale & Sheffey, 2002; Winquist & Larson, 1998). It implies that the performance of a group is not necessarily raised only by increasing the quantity of information exchanged, which was the goal of much previous research (e.g., Frey, Schulz-Hardt, & Stahlberg, 1996; Larson et al., 1994; Parks & Cowlin, 1996; Stasser, Taylor, & Hanna, 1989; Wittenbaum & Stasser, 1996; for a discussion see Reimer & Hoffrage, 2003). Rather, the *adaptive* selection of group decision strategies determines the success of a group. Thus, to be successful, a group has to select a strategy that fits to the structure of the task environment *and* to the features and composition of the group members (cf. Bottger & Yetton, 1988; Hill, 1982).

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Notes

1. The reason for this uneven distribution was methodological: To be able to test for less-is-more effects (Gigerenzer et al., 1999; Hertwig & Todd, 2003), Reimer and Katsikopoulos (2004) had selected a subsample of American cities such that the validity of the recognition heuristic was considerably higher than the validity of group members' knowledge (in the unselected sample, the average recognition validity was .72 and knowledge validity was .65). Their study was the first, showing that the less-is-more effect also exists on the group level, that is, that limited knowledge can result in a better inferential accuracy than more complete knowledge.
2. For eliminating the completely unknown companies, we conducted a pilot study (that contained only a recognition test) with 40 laypeople (24 females, mean age 23.5 years, SD = 2.51).
3. This was achieved by basing the pairing on the recognition answers of each member and maximizing the numbers of pairs in which only two members recognized each company.
4. The DCS was applied by two trained coders. Six video-taped discussions of 30 min each were coded by both coders to determine the intercoder agreement (being $\kappa = 0.82$ for 1 = *the recognition cue* and $\kappa = 0.83$ for 2 = *knowledge cues*), which was satisfactory and thus justified the decision to have the remaining 37 discussions coded by only one coder each. Due to incomplete or partly damaged videotapes, approximately 3% of the observation data (66 of 2,150 comparison pairs) were missing.
5. None of the dependent variables was affected by the time condition, except the behavioral correlates, as revealed by a multivariate analysis of variance with the predictive and theoretical accuracies of the RBM and the KBM, respectively, and the achieved accuracy per group as dependent variables, and the time conditions as independent variable, $F_{\text{time}}(5, 37) = 0.700$, $p = .63$, $\eta_p^2 = .09$.
6. Both models fail to make predictions if there is no majority of one kind but, members using the same individual strategy contradict each other. In 14 (i.e., 1.5%) of the 907 trials (2,150–1,243) in which the RBM made no prediction, there was a

contradiction between two recognition heuristic users. In 225 (i.e., 19.8%) of the 1,135 trials (2,150 – 1,015) in which the KBM made no prediction, there was a contradiction between two knowledge users.

7. We ran the same classification procedure also including the predictive accuracy of the SM in the comparison. Ties between the predictive accuracies of the RBM or KBM and the SM, respectively, were resolved with the advantage going to the RBM or KBM. This classification resulted in 10 RBM groups, 24 KBM groups, and 6 SM groups. Using those 34 RBM and KBM groups rather than all 38 groups yielded the same results as all subsequent analyses.
8. One reason could be that KBM group members received more difficult pairs by accident. This was, however, not the case: The mean differences between the market capitalizations of the two companies of a pair were equal for KBM and RBM groups (M_{KBM} = €11,242,721,413, SD = 17,046,506,195 vs. M_{RBM} = €11,535,090,275, SD = 17,261,293,274), $t(1898) =$ 0.34, $p = .74$, $d =$ 0.02.
9. Results stayed the same if we analyze base-rate corrected relative frequencies of speaking first instead, that is, if we control for the number of members using the recognition heuristic (R members) or knowledge (K members) per group: K members spoke relatively more often first in KBM groups than in RBM groups, whereas the reverse was true for R members, $F_{group\ type}(1, 34) = 2.99$, $p = .09$, $\eta_p^2 = .08$. Again, no effect of the time condition was revealed.

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