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Learning While Deciding in Groups


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Learning While Deciding in Groups

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Abstract and Keywords

Groups are used to make many important societal decisions. Similar to individuals, by paying attention to the information available during the decision processes and the consequences of the decisions, groups can learn from their decisions as well. In addition, group members can learn from each other by exchanging information and being exposed to different perspectives. However, groups make decisions in many different ways and the potential and actual learning that takes place will vary as a function of the manner in which groups reach consensus. This chapter reviews the literature on group decision making with a special emphasis on how and when group decision making leads to learning. We argue that learning is possible in virtually any group decision-making environment, but freely interacting groups create the greatest potential for learning. We also discuss when and why groups may not always take advantage of the learning potential.

Keywords: group decision making, group learning, aggregation strategies, prediction markets, judge–advisor systems, group biases

Life is full of decisions. On any given day, for example, people choose when to leave for work, what project should take precedence, what route to take home to minimize traffic, what to have or where to stop for dinner, and what time they should go to bed. Many of these decisions are made with little thought, and the outcomes often are fairly routine (e.g., most people leave for work at a similar time each day depending on when they need to make it to their workplace). More important or complex decisions require acquiring information, compiling it into a usable form, and then weighing decision options based on the information to choose the best (or at least an acceptable) alternative. But regardless of their importance or complexity, the outcomes people receive following a decision allow them to learn about both the decision environment and the decision processes used. If the outcomes match or exceed expectations (e.g., reached work on time, recently purchased product works better than expected, etc.), people will continue to make similar decisions using similar processes. However, if the outcomes are below expectations (e.g., showing

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up late for work, the product does not function properly, etc.), then different decision alternatives will be considered (e.g., leaving for work earlier, trying another product brand, etc.). Thus, virtually all decision situations allow for the possibility of learning.

Although decision making is often seen as an individual behavior, many decisions involve a social or group component (Kerr & Tindale, 2004; Tindale, Talbot, & Martinez, 2013). For example, parliaments, city councils, and corporate boards make many of the important decisions for their constituents or organizations. However, even when a single person makes the final decision, other people may have been involved. People often talk to friends and family members about important decisions in their lives. Managers typically discuss decisions with other managers or members of their departments before finalizing decisions. Even individual purchase decisions often are informed by consumer comment lists or listservs relevant to the decision. The social nature of these decisions provides additional avenues for learning. Learning not only occurs from evaluating decision outcomes; it can also occur prior to making a decision through interactions with other people.

There are also a number of ways that learning can occur during group or collective decision making. Much like individuals, groups can learn from the feedback they receive from the environment. If their decision leads to the outcomes they intended, then they made a good decision (although outcome feedback is not always reliable). If the decision leads to poor outcomes, the group may alter its decisions in the future to avoid such outcomes. Groups can also learn from observing the outcomes received by other similar groups. Often groups faced with important decisions will attempt to gather information from external sources before making a decision, which offers another avenue for learning. Groups can also learn from observing what other groups have done, even if the outcomes of their decisions are unknown. If nothing else, knowing what other groups have done can expand the pool of possible decision alternatives.

Learning in groups can flow from the resources contained within the group as well. Often group members bring different types of knowledge and experiences to the decision situation. During group interaction and discussion, different group members can learn whether their preferences are shared by other group members or whether they hold minority opinions (Levine & Tindale, 2015; Nemeth, 1986). Also, group members can learn new information as other members share the information they possess (Stasser & Titus, 1985; Stasser, 1999). Although research has shown that groups are not naturally inclined to optimal information sharing (see Lu, Yuan, & McLeod, 2012, for a recent review), there are many group decision situations where members do learn new information from other members (Tindale, Stawiski, & Jacobs, 2008).

Although there are many ways that learning can occur during group decision making, the amount and type of learning is constrained by the way in which the group decisions are made (Kerr & Tindale, 2011). A number of group decision-making methods simply aggregate member preferences to produce a final judgment or decision (Larrick & Soll, 2006). Although these methods tend to produce quite accurate judgments (the “wisdom

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of crowds” effect; Surowiecki, 2004), they often limit the amount of learning that can occur. Other methods (e.g., the Delphi method) allow limited feedback to members during the group decision-making process, but they still limit the amount of learning that can occur. Recent work using auctions or prediction markets (Forsythe, Nelson, Neumann, & Wright, 1992; Maciejovsky, & Budescu, 2007) has been shown to be accurate and also allow for learning to occur under some conditions. Another common group decision-making technique that has garnered a fair amount of research attention involves a single decision maker with one or more advisees who provide input to the decision-making process (i.e., judge–advisor systems; Sniezek & Buckley, 1995). Such systems should, in principle, lead to asymmetric learning (i.e., the judge learns more than the advisors), but little research has explored judge–advisor systems as group learning environments. Finally, groups that make face-to-face decisions with deliberation should produce many types of learning. However, even under such optimal circumstances, learning may or may not occur in such groups (Baumann & Bonner, 2011; Littlepage, Robison, & Reddington, 1997).

In this chapter, we will review the current literature on group decision making in relation to how groups and group members can learn during the process. Throughout the chapter we will consider both learning by individual group members and learning by the group collectively as forms of “group” learning. Although they are not identical (e.g., a single member may learn something but choose not to share it with the other members so the group never collectively knows or uses the information), they both involve learning, and individual member learning may often lead to more thorough collective learning as well. Some of the work we review directly addresses what and how groups learn while deciding (e.g., Baumann & Bonner, 2011). However, as previously argued, most if not all decision situations allow for learning. Thus, we also review work on group decision making that does not focus on learning per se but is relevant to what groups do/could learn during the decision-making process. In addition, much of our focus will be on how groups access, share, and use information in the process of making decisions and how such information processing affects the potential for learning (Hinsz, Tindale, & Vollrath, 1997).

We will organize the group decision-making literature according to the amount of member interaction that the decision-making process allows (Kerr & Tindale, 2011; Tindale & Kluwe, 2015). As one might expect, the more interaction the decision-making process allows, the greater the opportunity for group and group member learning. However, even when member interaction is limited, groups can still learn, and learning can be quite meager even when conditions appear optimal. We will conclude with a discussion of what we know so far and where future research is needed to further delineate the relationship between decision making and learning in groups.

Simple Aggregation: Review

Although group decision making is often conceptualized as a set of individuals discussing and reaching consensus on some course of action, many group decisions are not made that way. Often, members' preferences are simply aggregated by one member (or a person outside the group), and the aggregate is used as the group's position or choice. For example, elections or surveys are often used to guide decision making in larger organizations where face-to-face interaction among all the members would be impossible or prohibitively expensive to produce. Usually such systems are justified on fairness or equal representation principles, but most of the relevant research has shown that such systems can produce quite accurate judgments (Ariely et al., 2000; Armstrong, 2001; Hastie & Kameda, 2005; Larrick & Soll, 2006). This accuracy, relative to judgments made by individuals, was referred to by Surowiecki (2004) as "the wisdom of crowds." This phenomenon has now been replicated many times in a number of diverse problem domains (Larrick & Soll, 2006; Surowiecki, 2004). Ariely et al. (2000) showed that, assuming pairwise conditional independence and random individual error distributions (although this assumption is not satisfied in many decision contexts), the average of J probability estimates (J = the number of estimators) will always be better than any of the component individual estimates. In addition, as J increases, the average will tend toward perfect calibration diagnosticity (accurate representation of the true state of affairs), even when information provided to the various estimators is less than optimal. In addition, Johnson et al. (2001) empirically showed the accuracy advantage of the average probability estimate to be robust over a number of conditions, even when individual estimates were not independent. Recent work on forecasting has shown that a simple average of multiple independent forecasts will be more accurate than the responses of individual experts and will often be as accurate as the output of more sophisticated aggregation techniques (Armstrong, 2001).

Larrick and Soll (2006) have explained the advantage of simple averages over individual judgments using the concept of "bracketing." Assuming that the group member judgments are independent, different members will make somewhat different estimates, with some of the estimates above the "true score" and others below it. Thus, the estimates "bracket" the true score. When this is true, it can be shown mathematically that the average of the multiple estimates will always be more accurate than the average individual judge. If the true score is well bracketed by the multiple estimates (near the median or average), the aggregate accuracy will be far superior to judgments by single individuals. However, even if the true score is closer to one of the tails of the distribution, the average will still outperform the typical individual, though not to the same degree. Larrick and Soll (2006) also show that even when the true score is not bracketed by the estimates, the group (average) will do no worse than the typical individual judge.

Although the simple average is the most often used aggregation technique, there are others that also have been used to provide group-level responses. A number of authors have argued for the median as a viable, if not preferred, alternative to the mean (Black, 1958; Hora, Fransen, Hawkins, & Susel, 2012; Kerr & Tindale, 2011). In many

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circumstances, means and medians will be very similar, especially when large groups are used. However, when group size is small, medians are less sensitive to extreme member estimates and may provide a more accurate representation of the central tendency of the group. When decision problems involve discrete alternatives, aggregation systems often use the mode (majority/plurality response) to define the group response. There is considerable evidence that majority/plurality responses do quite well in a number of decision situations and often perform better than an individual baseline (Hastie & Kameda, 2005; Kerr & Tindale, 2004). In addition, Sorkin, West, and Robinson (1998) have shown that majority models come very close to optimal performance when group member expertise is not knowable.

Although central tendency aggregation models have been shown to do quite well in various situations (Larrick & Soll, 2006), a number of researchers have attempted to improve aggregate forecasts by modifying the aggregation procedure, or the weights given to individual members (Aspinall, 2010; Budescu & Chen, 2014; Lee, Zhang, & Shi, 2011). Some attempts have been made to use Bayesian models to aggregate multiple forecasts, though it is often difficult to define the appropriate prior probabilities and likelihood functions (see Budescu, 2006). Others have proposed weighting the opinions of more expert members more heavily than those of members with less expertise (Aspinall, 2010). However, regression to the mean and measurement error can lead to overweighting of supposed experts in future aggregations. Recently, Budescu and Chen (2013) formulated a method for improving group forecasts by eliminating group members whose forecasts detract from the group performance. They had group members make probabilistic forecasts for a variety of events and then assessed whether the group's forecast was better or worse when each group member was included in (or removed from) the aggregate. By only including those members whose forecasts showed a positive influence on accuracy, they consistently improved the accuracy of the group forecasts relative to the simple average and other less effective weighting schemes, and the improvements persisted for future judgments not used to define the inclusion criteria (see also Mellers et al., 2014).

Implications for Learning

The learning associated with simple aggregation could range from almost none to a substantial amount depending on what role a person plays in the process and the type of feedback available. Given that aggregation tends to work best when individual estimates are independent (Ariely et al., 2000), the process works best when individuals are not allowed to interact. Thus, members may learn nothing more than they already knew. Even if members learn of the final decision, they will not necessarily know how the aggregation affected the final choice. However, people involved in the aggregation (via summarizing and analyzing the data) can potentially learn quite a bit. Organizations quite often survey members to help make decisions on important issues (Judge & Kammeyer-Mueller, 2012). Given the general accuracy of such aggregations, organizations can learn what the most likely outcome is or the most typical members' preferences are and use that information

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to make more informed decisions. The organization can also learn the degree of consensus or dispersion of opinion of its members on the topic of interest.

If members receive feedback about the aggregation process and the outcomes thereof, they can potentially learn a great deal from the process. For example, often elections are won based on a majority or plurality decision rule. In such cases, simply finding out who won provides insight into the preference distribution. It also informs members whether their preferences were similar to or different from others. Often feedback on more than just the final outcome is also available. Most media reports concerning elections also present information on the margin of victory and discuss how different segments of the population (e.g., race, gender, region, income level, etc.) voted. Thus, members can learn much about their position vis-à-vis that of others within the society or organization. In addition, research has shown that simply learning whether one is in the majority or the minority on an issue can lead to different thought processes (Nemeth, 1986) and to different levels of effort to learn more information about the issue (Levine, Bogart, & Zdaniuk, 1996). Thus, under the right circumstances, even decision processes that allow for no interaction among group members can still lead to learning for both the group members and the larger organization within which they are embedded.

Aggregation With Limited Interaction: Review

Although simple aggregation tends to produce fairly accurate decisions, a potential downside is that members do not share information or defend their positions. In addition, group members often remain unaware of others' positions and the final group product. Although little is often gained by member exchanges (Armstrong, 2006; Lorenz, Rauhut, Schweitzer, & Helbing, 2011), it is difficult for members with particular insights or important information to have influence without some type of interchange among group members (Kerr & Tindale, 2011). Obviously, full group deliberation (a topic discussed later) would allow such members to share and defend their positions. However, the most influential members in freely interacting groups are not always the most accurate or correct because influence is driven by status or confidence (Littlepage et al., 1997). Thus, decision-making approaches are often compromise procedures in which some information exchange is allowed but pressures toward conformity and incidental influence are minimized.

Probably the most famous of these procedures is the Delphi technique (Dalkey, 1969; Rowe & Wright, 1999; 2001). This technique has been used in idea generation and forecasting most often, but it has also been adapted to other situations (Rohrbaugh, 1979). The procedure starts by having a group of (typically) experts make a series of estimates, rankings, idea lists, and so forth on some topic. A facilitator then compiles the list of member responses and summarizes them in a meaningful way (e.g., mean rank or probability estimate, list of ideas with generation frequencies, etc.). The summaries are given back to the group members, and they are allowed to revise their initial estimates. The group members are typically anonymous and the summaries do not specify which

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ideas or ratings came from each member. This procedure allows information from the group to be shared among the group members but avoids conformity pressure or undue influence by high-status members. The procedure can be repeated as many times as seems warranted but is usually ended when few if any revisions are recorded. The final outcome can range from a list of ideas, each associated with the number of members mentioning it, to a choice for the most preferred outcome or the central tendency (mean or median) estimate. A number of related techniques (e.g., nominal group technique; Van de Ven & Delbecq, 1974) use similar procedures but vary in terms of how much information is shared and whether group members can communicate directly. Overall, the purpose of these procedures is to allow for some information exchange while holding potential distortions due to social influence in check. Research on the Delphi technique has tended to show positive outcomes. Delphi groups do better than single individuals and do at least as well as, if not better than, face-to-face groups (Rohrbaugh, 1979). They have also been found to work well in forecasting situations (Rowe & Wright, 1999, 2001).

A limited-interaction aggregation technique that is useful for multicue decision environments is the social judgment technique (Brehmer, 1976), which is based on the *lens model* approach developed by Brunswick (1955) and applied to decision analysis by Hammond (1965). In the group decision-making domain, the technique is used to help resolve cognitive conflicts among group members. Cognitive conflicts involve members' differences in how to achieve a particular set of outcomes that are common or preferred among the group members (e.g., how to choose the best advertisement for our shared business interests). The technique begins by having individual members make a series of judgments based on cues available in the environment. A non-group member then analyzes each individual's mental decision model by calculating the regression weights for each cue for each member. The individuals' "mental models" are then shared with the members of the group. This allows members to see both how they made their judgments and also why other members might have made different judgments. At this point, the members then discuss the decision problems and attempt to reach consensus on the best model and subsequently the best judgment. The discussion should focus on the differences among the models rather than simply arguing over which of the judgments was best. The technique has not received that much empirical attention, but studies that have compared it to other decision techniques show it performs as well as other techniques (e.g., Delphi and nominal group technique) and can lead to greater member satisfaction with the process (Rohrbaugh, 1979, 1981).

A more recent technique involving aggregation with limited interaction uses prediction markets (cf. Wolfers & Zitzewitz, 2004). Much like financial markets, prediction markets use buyers' willingness to invest in alternative events (e.g., Obama will win vs. McCain will win in the 2008 US Presidential election) as a gauge of their belief in the likelihood that the event will occur. These markets typically do not prohibit direct communication among forecasters/investors/bettors, but, in usual practice, there is little such communication (if any). However, since the value placed on the assets is typically set in an open market of buyers and sellers, those already in or out of the markets can be informed and swayed by various market indicators (e.g., movements in prices, trading

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volume, volatility), and thus mutual social influence can occur through such channels. The simple “initial forecasts–group aggregation–final forecast” sequence does not really apply to this method very well. It is a much more dynamic and continuous aggregation process, in which bids and offers can be made, accepted, and rejected by multiple parties, and the collective expectations of the “group” can continue to change right up to the occurrence of the event in question (e.g., an election). Except for those with ulterior motives (e.g., to manipulate the market, or to use the market as a form of insurance), investments in such markets are likely to reflect the investors’ honest judgments about the relative likelihood of events. Members can use current market values to adjust their thinking and learn from the behavior of other members. However, such investment choices are not accompanied by any explanation or justification. Indeed, such investors may even have incentives to withhold vital information because it would make other investors’ choices more accurate (e.g., inflate the price of a “stock” one wants to accumulate). Thus, in terms of opportunities for mutual education and persuasion, prediction markets fall somewhere between statistical aggregation methods (which allow none) and face-to-face groups (which allow many). Although these techniques sometimes overestimate the likelihood of very rare events, they have been shown to be extremely accurate in a number of group decision environments (Forsythe, Nelson, Neumann, & Wright, 1992; Rothchild, 2009; Wolfers & Zitzewitz, 2004).

Implications for Learning

Each of the group decision-making procedures in this section provides additional avenues for learning compared to the simple aggregation procedures (Kerr & Tindale, 2011). However, the number of additional avenues and the amount of actual learning that occurs depend on how they are used. For example, the Delphi technique explicitly allows for preference or response information to be shared among group members. Usually the information is provided with frequency counts indicating how many members chose or endorsed a particular response. Thus, members can learn whether their responses were normative, or typical, for this particular group. The technique does not require members to learn how or why responses were chosen, but it does not explicitly rule out such information. If members were chosen for their particular areas of expertise, members whose choices were divergent from most others’ choices may begin to rethink why they chose how they did and thus learn from the process (Burnstein, 1982). The technique also involves multiple rounds in most cases, so members can see how preferences changed over time and which responses tended to gain or lose members. The organization using the technique also gains all of this information. However, members (and the organization) typically do not gain information about the reasoning behind member responses because they are not provided (though, in theory, they could be).

The nominal group technique (NGT) and the social judgment technique (SJT) start out much like the Delphi technique by asking individuals to respond to a particular decision issue. NGT mimics the first round of the Delphi technique almost exactly, while SJT asks individuals to make a series of multicue judgments in the same domain. However, after the first round, NGT and SJT involve an open discussion among members rather than

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simply a chance to realign their initial judgments or lists. Thus, members can learn from both the initial information provided by the summarization performed after the first round and from the interaction among the members. Members can exchange information about the pros and cons of each alternative and, in the case of SJT, they can also discuss the reasoning behind the cue-weighting schemes they used, assuming they were cognizant of the schemes they were using (Hastie & Dawes, 2001). We will go into more detail about the pros and cons of group discussion on learning in a later section, but it can be noted here that typically discussion allows for additional avenues for learning.

There is not much research on learning from prediction markets, although there is a growing body of evidence supporting their accuracy as a decision-making procedure (Rothchild, 2009; Wolfers & Zitzewitz, 2004). Organizations that use prediction markets for decision making can learn from the final market values and outcomes in the same way organizations learn from aggregated judgments in surveys. However, little attention has been paid to what the individual investors or participants learn in prediction markets. A notable exception is a study by Maciejovsky and Budescu (2007), who had people participate in a competitive auction bidding for information in order to solve the Wason card task problem, which requires testing a hypothesis using evidence. The task tends to be quite difficult, and base rates for solution in standard populations are 10% or less. Maciejovsky and Budescu ran auctions under a number of different feedback conditions and assessed both group performance during the auctions and individual performance on the task after participating in the auctions. The key aspect for learning appeared to be feedback. When no feedback was given to members, no evidence of learning was found. However, if members received either private feedback about their bids on solutions or public feedback about both their and others' bids, participants were better at solving such problems (chose the appropriate evidence in an efficient manner) after having participated in the auctions. Performance both during the auction and on the subsequent transfer-of-learning task was best in the public feedback condition. Thus, even with very minimal information exchange among members, groups and their members can learn to solve difficult problems simply by observing the market outcomes associated with their behavior.

Judge-Advisor Systems: Review

Vroom and Yetton (1973) argued that one of the ways managers make decisions is through consultation. That is, the decision is made by the manager but only after getting advice from important members of the team or organization. Snizek and Buckley (1995) referred to this mode of social decision making as the "judge-advisor" systems approach. The judge is responsible for the final decision, but he or she seeks out suggestions from various advisors. Such systems have recently received a fair amount of research attention (see Bonaccio & Dalal, 2006, for a review). Based on the research discussed earlier, unless the judge had far more expertise than an advisor, the judge should weight the advisor's advice equal to his or her own opinion. Although receiving advice usually does improve judges' decisions relative to not receiving advice, a vast amount of research has

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shown that judges tend to weight their own opinion more than twice as heavily as the advice they receive (Larrick, Mannes, & Soll, 2012). This “egocentric advice discounting” (Yaniv, 2004; Yaniv & Kleinberger, 2000) has been found to be extremely robust and has been replicated in a large number of decision situations with different types of judges and advisors (Banaccio & Dalal, 2006).

Importantly, judges do take the expertise of their advisors into account when evaluating their position. Thus, judges discount their advisors’ view less when the advisors are known experts or their past advice proved to be accurate (Goldsmith & Fitch, 1997). Judges are also more likely to use advice when making judgments in unfamiliar domains (Harvey & Fisher, 1997), and they learn to discount poor advice to a greater degree than good advice (Yaniv & Kleinberger, 2000). However, judges are not always accurate in their appraisals of an advisor’s expertise. Sniezek and Van Swol (2001) have shown that one of the best predictors of a judge’s use of advice is advisor confidence, which is poorly correlated with advisor accuracy. Less discounting has been found for advice that is solicited by the judge than for advice that is simply provided (Gibbons, Sniezek, & Dalal, 2003). In addition, judges discount less when the task is complex (Schrah, Dalal, & Sniezek, 2006), when there are financial incentives for being accurate (Sniezek & Van Swol, 2001), and when they trust the advisor (Van Swol & Sniezek, 2005). However, discounting is present in virtually all judge–advisor situations, and it almost always reduces decision accuracy.

A number of different explanations for the egocentric discounting effect have been proposed. One of the earliest explanations was based on anchoring and adjustment (Tversky & Kahneman, 1974). Harvey and Fischer (1997) argued that the judge’s initial estimate served as an anchor and judges did not adjust enough when they were provided with the advice. However, studies have shown the discounting effect even when no initial evaluation is present upon which to anchor (Banaccio & Dalal, 2006). Yaniv (2004) has argued that the effect is due to the information advantage judges have about their own estimates. Judges should know why they chose their initial position, yet they may know very little about why advisors gave the advice they did. Yaniv and Choshen-Hillel (2012) showed that forcing judges to choose initial positions based on virtually no information drastically reduced the discounting effect. However, Soll and Larrick (2009) found almost no effect of varying the amount of information judges had about the advisors’ reasons for their choices. Krueger (2003) has argued that the effect is simply another instance of a general egocentric bias that occurs in many domains of judgment. The bias leads people to focus their attention on certain aspects of the self, and they typically perceive themselves as more capable than others on average. Larrick, Mannes, and Soll (2012; see also Soll & Mannes, 2011) also argue that judges’ positions are “owned” by them and become part of the self, thus making them difficult to give up.

Implications for Learning

Similar to prediction markets, most of the research on judge–advisor systems has focused on either judgment accuracy or the weighting of the advice in final judgments (Banaccio & Dalal, 2006). Most of this research has shown that receiving advice improves performance and that weighting the advice equal to the judge’s initial judgment leads to the best performance. From this perspective, most decision makers do not learn optimally because they tend to underweight the advice they receive when forming their final judgment.

Little research in this area attempts to assess “transfer,” that is, how well people make judgments on similar issues following the receipt of advice. However, a recent study by Tindale, Jacobs, and Starkel (2009) has begun to address these issues in a limited domain. Tindale et al. had individuals work on probabilistic inference tasks that tend to produce responses that violate the laws of probability (Tversky & Kahneman, 1974, 1983) but also allowed them to receive advice in a standard judge–advisor system format. However, they controlled the type of advice the judges received. Each participant received information from two advisors. Both advisors gave normatively correct responses, normatively incorrect responses (consistent with the typical participant response), or split responses, with one advisor giving correct advice and the other giving incorrect advice. In addition, half of the participants received statements from the advisors justifying their responses, and half did not. The correct advice was paired with statements based on normatively correct logic, while the incorrect advice was paired with statements based on the biased logic that leads to the errors. Finally, all participants responded to a second problem of the same type. For the problem where advice was given, only participants who received two correct pieces of advice showed any improvement. However, for the second problem, only participants who received two pieces of correct advice paired with normatively correct logic statements showed any improvement. Participants who did not receive the arguments responded no better than participants who received poor advice or no advice at all. Although the problems used were of a limited nature, it appears simply receiving advice can lead to better judgments on the problem for which the advice was given, but this may not lead judges to learn how to make better judgments in the future.

Fully Interacting Groups: Review

Most of the research on group decision making has focused on groups in which members meet together face to face and discuss a decision problem until they reach consensus. Early research in this area focused on member preferences as the major feature predicting group decision outcomes (Davis, 1973; Kameda, Tindale, & Davis, 2003). More recent research has focused on how groups process information (Hinsz, Tindale, & Vollrath, 1997) and the degree to which available information is used by the group (Brodbeck, Kerschreiter, Mojzisch, Frey, & Shulz-Hardt, 2007; Lu, Yuan, & McLeod, 2012). Kameda, Tindale, and Davis (2003; see also Tindale & Kameda, 2000) have proposed that “social sharedness” can explain many of the findings associated with

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attainment of group consensus. Social sharedness refers to task-relevant cognitions (broadly defined) that the members of a group have in common, or share, which exert a greater influence on group decisions than do similar cognitions that are not shared among the members. These shared cognitions can vary from preferences for decision alternatives or information about the alternatives to heuristic information-processing strategies that the members cannot even articulate. However, the greater the degree of sharedness of a particular task-relevant cognition, the greater the likelihood that it will influence the group decision. In general, social sharedness is often adaptive and probably evolved as a useful aspect of living in groups (Kameda & Tindale, 2004). However, a shift in context in which the shared cognition is inappropriate to the current situation can lead groups to make poor decisions.

Socially Shared Preferences

Early work on group decision making tended to focus on the distribution of initial member preferences and how such preferences get combined into a group, or collective, response (Davis, 1969, 1973; Steiner, 1972). This is known as the “combinatorial approach” to group decision making (Davis, 1982). One of the most widely used frameworks under this approach has been social decision scheme (SDS) theory (Davis, 1973). SDS theory assumes that the group members know a set of discrete decision alternatives and that each member favors a particular alternative at the beginning of deliberation. It then attempts to describe the group consensus process using a matrix of conditional probabilities mapping different member preference distributions to different consensus choices made by the group. For example, in a six-person group choosing between two decision alternatives (e.g., guilty vs. not guilty in a jury), there are seven ways in which the group members might initially array themselves across the alternatives: six guilty and zero not guilty, five guilty and one not guilty, ... zero guilty and six not guilty. Given a population of potential group members in which some proportion favors one alternative over the other (e.g., 40% favor guilty and 60% favor not guilty), the likelihood of each initial preference distribution is estimable. The SDS matrix then maps each initial preference distribution to a distribution of group outcomes based on theory or a set of assumptions concerning the consensus process by which members’ initial preferences are reconciled.

One of the key findings of studies using this framework is that majority/plurality models do a fairly good job of representing the data from many group decision-making studies (Kameda, Tindale, & Davis, 2003; Kerr & Tindale, 2004). Although some contexts are better described by higher order majorities (e.g., criminal mock juries are well described by two-thirds majority models), the position with the largest initial support tends to be chosen by the group in most types of decisions. Kameda et al. (2003) have argued that majority/plurality models reflect social sharedness at the preference level. One of the key aspects of majority/plurality processes is that they tend to exacerbate in the final group distribution those response tendencies that are prevalent at the initial individual level. Thus, in situations where the outcome of a decision can be defined as good or bad (or at least better or worse) by some criteria, a majority/plurality process leads groups to make

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better decisions than the average individual when individuals tended toward the “good” response alternative. However, exactly the same process leads groups to make worse decisions than the average individual when individuals tended toward the “bad” response alternative. Thus, since the majority/plurality process pushes the group in the direction initially favored by most of its members, it can lead to either good *or* poor decisions, depending on how members initially lean.

Fortunately, it appears that majority/plurality processes tend to lead to good decisions in many natural decision settings involving groups (Hastie & Kameda, 2005; Sorkin, Hays, & West, 2001; Sorkin, West, & Robinson, 1998). Hastie and Kameda (2005) compared a variety of different ways groups could choose to move forward in an uncertain environment with many different response options. Overall, they found that a simple majority/plurality process (i.e., going with the alternative with the greater degree of support) was more accurate than any other decision rule with similar computational complexity. Majority models did even better than best member models (going with the alternative preferred by the person whose choices have been most accurate in the past) and performed similarly to models that required much greater levels of computation (e.g., weighted averaging models based on past performance). Hastie and Kameda (2005) argued that the generally high levels of accuracy combined with the low computational load might explain why majority processes are so pervasive in social aggregates. In a similar vein, Sorkin et al. (2001) developed a signal detection model of group performance and found that optimal group performance based on weighting individual members by their decision accuracy is only marginally better than using a majority/plurality process and that majorities tended to perform very close to optimal levels. Using these same models, Sorkin and his colleagues also showed that simple majorities tend to perform better than “super” majorities (those requiring 60% or 67% member agreement to reach a consensus; Sorkin et al., 1998). Thus, although majority/plurality processes can both attenuate and exacerbate errors in group decision making, they tend toward the former in many natural environments.

Majority/plurality models are well defined when decision alternatives are discrete and groups are asked to choose one of the possible alternatives. However, many group decision tasks require groups to reach consensus on a point along a continuum (e.g., amount of money to invest or an estimation of the likelihood of some event) where it is unlikely that members’ specific positions will overlap. Thus, majority/plurality models of group choice are not appropriate for groups making ratings or estimations (Stasser & Dietz-Uhler, 2001). Although a variety of models can be (and have been) applied to these types of situations (see Grofman & Owen, 1986; Hinsz, 1999 for examples), we will focus mainly on three that have received a reasonable amount of empirical support.

One of the most basic models of group judgment on estimation tasks is a simple arithmetic average. Assuming each group member starts discussion with a well-defined preference point, and assuming each member is equally influential, the mean of the initial distribution seems a reasonable compromise. It is also possible that means or other central tendency points serve as focal points (Schelling, 1960) and provide a salient

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resolution point for resolving preference differences. A number of studies have found that a simple averaging model provides a decent approximation of final group outcomes (Gigone & Hastie, 1993), especially when groups are making multiple judgments in a limited timeframe.

Another model that has fared well empirically is the median model (Black, 1958; Crott et al., 1991; Davis et al., 1997; Laughlin, 2011). Black's (1958) work on social choice models showed that median positions form an equilibrium under certain circumstances and thus are likely to be stable group choice outcomes. His median voter theorem posited that when member preference curves are single peaked (i.e., each member has a single preferred point along the response continuum and a member's evaluation of other points on the continuum is relatively lower as a function of his or her distance from that preferred point), the median of the members' initial preferences is the most stable outcome (see Laughlin, 2011, for a more thorough discussion of social choice models). Crott et al. (1991) showed that a median model could explain group polarization and provided a very good fit to group consensus data on choice dilemma items. Davis et al. (1997) also found a median model to provide a good fit to damage award judgments by mock civil juries.

Davis (1996) also derived a group consensus model for continuous response dimensions called the social judgment schemes (SJS) model. The model assumes that the amount of influence a particular group member has on the final group response is an inverse exponential function of the sum of the distances from that member's position to all other members' positions. Thus, members who are most similar to other members on the response dimension have greater influence on the final group response than do members whose preferences are less similar to other members overall (see Davis, 1996; Kameda, Tindale, & Davis, 2003, for a more formal discussion of the model). The model is similar to a median model in that it underweights deviant or outlying positions, but it differs from a median model in that all group members get at least some influence on the final decision. Research has shown a good fit between model predictions and data for consensus group judgments in a number of group decision settings (Davis et al., 1997; Hulbert, Parks, Chen, Nam, & Davis, 1999; Ohtsubo, Masuchi, & Nakanishi, 2002) and also demonstrated its similarity to the median model (Davis et al., 1997).

Kameda, Tindale, and Davis (2003; see also Tindale & Kameda, 2000) have argued that both the SJS model and the median model are similar to majority/plurality models in that they represent social sharedness at the preference level. On a continuous response dimension, members often will not have exactly the same preference. However, the SJS model explicitly gives more weight to members whose preferences share similar spaces on the dimension, and median models tend to do this as well, though less directly by basically ignoring outliers. Thus, the member preferences that share a relatively narrow region on the response dimension become quite influential, and the greater the degree of sharedness (the more members who all share the same general area of the response dimension), the more likely it is that the group's final response will be located within that region. Much like majority/plurality processes, both SJS and median models predict

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groups will outperform individuals when most members show a bias toward better or more accurate positions on the continuum. However, if the typical individual is biased toward a less optimal or accurate scale position, these models will exacerbate the bias and lead to group performance decrements (Kerr & Tindale, 2011).

Socially Shared Cognitions

A major theme and dominant paradigm underlying much of the work on group decision making and performance over the past 25 years had its start with a paper by Stasser and Titus (1985). Using a paradigm called the “hidden profile,” Stasser and Titus showed that information that was initially shared by all of the group members was much more likely to be brought up during group discussion and was much more influential in the final group decision than was information held by only one member. By giving all the positive information about an inferior alternative to all members, and dividing the greater amount of positive information about a superior alternative among the group members so that each member only has part of it, Stasser and Titus showed that groups rarely shared enough of the unshared information to allow the group to realize that their initial consensus alternative was not as good as the optimal one. When all members shared all of the information, groups easily found the superior alternative. The “shared information” or “common knowledge” effect (Gigone & Hastie, 1993; Stasser & Titus, 1985, 1987), as it came to be called, has been replicated hundreds of times, and the hidden profile paradigm has dominated group decision-making research ever since (see Brodbeck et al., 2007, for review).

Probably the main reason the initial finding had such a profound impact on the field was that different information provided by different group members was seen as one of the key features of group processes that allowed groups to outperform individuals (Davis, 1969; Vinokur & Burnstein, 1974). Although there is now a fair amount of evidence that groups do in fact perform better if their members share their unique information (Brodbeck et al., 2007), it is also quite clear that groups do not do this naturally in many settings (Stasser, 1999). The fact that shared, as opposed to unshared, information plays a much larger role in most group decision settings definitely changed the way most researchers thought about groups and led to many studies attempting to better understand the phenomenon and discover ways to increase information sharing in groups.

Most of the current research findings have been nicely encapsulated by Brodbeck et al. (2007) in their information asymmetries model of group decision making. The model categorizes the various conditions that lead to poor information processing in groups into three basic categories. The first category, negotiation focus, encompasses the various issues surrounding initial member preferences. If groups view the decision-making task mainly as a negotiation with winners and losers, members negotiating which alternative should be chosen tend to focus on alternatives and not on the information underlying them. The second category, discussion bias, encompasses those aspects of group discussion that tend to favor shared versus unshared information (e.g., items shared by

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many members are more likely to be discussed). The third category, evaluation bias, encompasses the various positive perceptions associated with shared information (e.g., shared information is more valid, sharing shared information leads to positive evaluations by other group members). All three categories reflect features of typical group decision making and can lead to biased group decisions and inhibit cross-fertilization of ideas and individual member learning (Brodbeck et al., 2007).

A key aspect of Brodbeck et al.'s (2007) model is that the various aspects of information processing in groups only lead to negative outcomes when information is distributed asymmetrically across group members, as when a hidden profile is present. Although such situations do occur and groups can make disastrous decisions under such circumstances (Janis, 1982; Messick, 2006), they are not typical of most group decision environments. In situations where members have independently gained their information through experience, the shared information they have is probably highly valid and more useful than unique information or beliefs held by only one member. Thus, the fact that members share preferences and information in many group decision contexts is probably adaptive and has generally served human survival well (Hastie & Kameda, 2005; Kameda & Tindale, 2006). In addition, groups are often (but not always) sensitive to cues in the environment that indicate that information is not symmetrically distributed (Brauner, Judd, & Jacquelin, 2001; Stewart & Stasser, 1998). Although minorities often are not very influential in groups, if minority members have at their disposal critical information that others do not have and that implies the initial group consensus may be wrong, other group members will pay attention to them. And, as discussed later, minority members who favor superior alternatives in environments where the superiority can be demonstrated can be very persuasive and lead majorities to switch their preferences (Laughlin & Ellis, 1986).

Given the pervasiveness of the shared information effect, a fair amount of research has focused on how to increase the likelihood that all relevant information is brought up during group discussion. One partial remedy is to make sure that groups have a record of all of the information present during group discussion (Sheffey et al., 1989). There is some recent evidence that group support systems can aid in this regard by allowing greater access to such information (Haseman & Ramamurthy, 2004). Studies have shown that groups that share an accuracy or problem-solving orientation to the decision problem bring up more unique information and perform better than groups with a consensus orientation (Postmes et al., 2001; Stewart & Stasser, 1995). Setting up a norm of information sharing or having a leader who encourages and stimulates information exchange throughout the process has shown promise in terms of greater information sharing and better performance (Larson, Foster-Fishman, & Franz, 1998). Also, instructing group members to avoid forming initial impressions or preferences, and not allowing such preferences if present to be shared early in the discussion, have also been shown to be helpful (Larson et al., 1998; Mojzisch & Schulz-Hardt, 2010). Setting up a transactive memory system (Wegner, 1987) where certain group members are responsible for certain types of information also has been shown to help groups process more information (Stasser, Vaughan, & Stewart, 2000). Groups that structure their tasks such

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that information is exchanged completely before any discussion of preferences or final decisions also tend to perform better (Brodbeck, Kerschreiter, Mojzisch, Frey, & Shulz-Hardt, 2002). The main things that seem to be important are a focus on information rather than preferences, memory aids or reduced information load per group member, and a focus on accuracy over consensus (Brodbeck et al., 2007).

Specific pieces of information (and preferences) are not the only types of cognitions that group members can share (Resnick, Levine, & Teasley, 1991; Tindale & Kameda, 2000). Laughlin (1980, 2011) has argued that one of the reasons that groups are usually better problem solvers than individuals is that group members often share a conceptual system that allows them to realize when a proposed solution is correct within that system. This shared conceptual system, or background knowledge, is what allows a minority member with a correct answer to influence a larger incorrect faction to change its preference to the correct alternative. Such situations are well described by SDS models called “Truth Wins” and “Truth Supported Wins” (Laughlin, 1980). Truth Wins predicts that any group that has at least one member with the correct answer will be able to solve the problem correctly (Laughlin, 1980). Truth Supported Wins argues that at least two members of the group must have the correct answer in order for the group to solve the problem correctly (Laughlin, 1980). For groups with more than four members, both models predict minority influence for minorities with the correct answer. Laughlin and Ellis (1986) proposed that such minority influence processes are likely to occur for demonstrable or “intellective” tasks (those that have a demonstrably correct solution) and that the shared conceptual system is a key component of demonstrability. For “judgmental” tasks (those without a demonstrably correct solution), majority/plurality processes are more likely to occur.

Tindale, Smith, Thomas, Filkins, and Sheffey (1996) argued that the shared conceptual system underlying demonstrability is one instance of what they referred to as “shared task representations.” They defined a shared task representation as “any task/situation relevant concept, norm, perspective, or cognitive process that is shared by most or all of the group members” (Tindale et al., 1996, p. 84). “Task/situation relevant” means that the representation must have implications for the choice alternatives involved, and the degree to which a shared representation affects group decision processes and outcomes will vary as a function of its relevance. Its influence will also vary as a function of the degree to which it is shared among the group members—the greater the degree of sharedness (the more members who share it), the greater its influence. If no shared task representation exists, or if multiple conflicting representations are present, groups will tend to follow a symmetric majority/plurality process. However, when a shared task representation does exist, the group decision process will tend to become asymmetric in favor of alternatives that fit within or are supported by the representation. Under such conditions, majorities/pluralities favoring an alternative consistent with the shared representation are more powerful than are identically sized majorities/pluralities favoring alternatives that are not consistent with or supported by the representation. In addition, minorities favoring an alternative consistent with the shared representation can

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sometimes be more influential than majorities favoring an alternative inconsistent with the shared representation.

Although Laughlin's work (1980; Laughlin & Ellis, 1986) is probably the strongest example of the effects of shared representations, a number of other potent examples exist. For example, much of the work on mock-jury decision making (MacCoun & Kerr, 1988; Tindale, Nadler, Krebel, & Davis, 2001) has shown that "not guilty" is an easier verdict to defend than "guilty." In other words, majorities favoring guilty are less successful than are majorities favoring not guilty. In addition, juries that are evenly divided between guilty and not guilty, and even some juries with a sizable minority favoring not guilty, reach a not guilty verdict much of the time (MacCoun & Kerr, 1988). MacCoun and Kerr showed that this asymmetry toward not guilty only occurs when juries are provided with a "reasonable doubt" verdict criterion. Tindale et al. (1996) argued that the reasonable doubt criterion serves as a shared task representation that tells jurors that they should look for and pay attention to reasonable doubts, and, if they exist, they should vote not guilty. More recent research has shown that religion can also work as a shared task representation. Smith, Dykema-Engblade, Walker, Niven, and McGrouh (2000) showed that minorities against the death penalty were persuasive in altering majority positions on the issue when they framed their arguments in terms of religion ("Thou shalt not kill"), whereas other types of arguments were ineffective. The shared religious orientations of the group members provided a context within which religious arguments could be very effective, even though they conflicted with the majority's initial preference.

A number of studies have shown that individual decision biases can act as shared task representations, unexpectedly leading groups to perform worse in certain decision situations than comparable single individuals. Tindale (1989) showed that biased feedback meant to induce a conservative (high criterion) promotion strategy in a job situation led minorities favoring the option to not promote an employee to win out over majorities favoring the option to promote. Tindale (1993) also showed that groups exacerbate typical error tendencies found at the individual level. Kahneman, Slovic, and Tversky (1982) describe how individuals often violate the rules of probability when making intuitive judgments that involve probabilities. For example, individuals sometimes estimate the likelihood of conjunctive events as greater than one or both of the elementary events involved in the conjunction. Since the conjunction is a subset of the elementary events, such a judgment is inconsistent with the basic laws of probability. Tindale (1993) found that for conjunctive probability judgments, where individuals are likely to make such errors, groups made even more errors. In addition, groups were more influenced by members who made errors than they were by members who avoided such errors. However, groups made fewer errors than individuals and did not show the asymmetric influence processes for conjunction problems that were not prone to individual errors. A number of studies have found similar error exacerbation tendencies with other types of decision biases (Argote, Devadas, & Melone, 1990; Hinsz, Tindale, & Nagao, 2008).

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Much of the work demonstrating the effects of shared task representations has involved ad hoc groups in which the shared background knowledge or approach to the task was acquired from members' prior experiences or shared environments. However, groups can create shared structures for defining how the group operates and approaches its task. Such structures are typically referred to as group-level or shared mental models (Cannon-Bowers, Salas, & Converse, 1993; Hinsz, 1995). Mental models refer to mental representations of the task and the behaviors associated with performing the task (Rouse & Morris, 1986). At the group level, mental models also involve roles and interdependencies among group members. Cannon-Bowers et al. (1993) differentiated between task models and team models. Task models involve the various steps involved in the task and the resources (equipment, etc.) necessary to accomplish it. Group, or team, models involve the information and skills that members have that are relevant to the task and the ways in which their skills and behaviors must be coordinated in order to move efficiently toward task completion. Team mental models can enhance performance to the degree that the models are accurate and the members all share the same model. Team training on both task and team models tends to improve performance by insuring that all aspects of both models are shared (Weiner, Kanki, & Helmreich, 1993). Such performance enhancements have been shown for cockpit crews on jetliners and surgery teams in hospitals.

However, sharedness for either the task or group model will only enhance performance to the degree that the model is accurate. Stasser and Augustinova (2008) have shown that distributed decision situations often produce better outcomes if information is simply sent up through the system by each group member without requiring any type of intermediary judgments by others. However, many groups assume that allowing judgments from various members is useful and thus use such a model to guide their behavior. Although aggregate judgments by many actors with different types and amount of information tend to be more accurate than judgments made by single individuals (Kerr & Tindale, 2011), in distributed systems where each member has only one type of information, asking all of the members to make judgments adds noise to the system. In addition, research has shown that it is better for members not to know that others might have the same information that they do because it reduces their feelings of criticality and decreases the likelihood that they will send all of their relevant information forward. Tschan et al. (2009) have shown that critical information easily available to emergency medical teams is often overlooked because each member assumes that someone else would have discovered and presented the information if it were relevant. Thus, intuitive mental models shared by group members can inhibit performance if they are inaccurate in terms of the task or if they lead to decreased information sharing. Once again, although shared mental models often tend to improve group decision making, they can also lead to poor decisions when what is shared is inappropriate for the particular decision context.

Implications for Learning

Fully interacting groups typically have the greatest potential for learning. Because all members can contribute to the discussion of the task, the knowledge each member has should be available to the group as a whole. However, research has shown that groups are not naturally optimal learning environments. Members do not share all of their information, and what information they do share is more likely to be commonly known rather than unique to a specific member (Stasser & Titus, 1985). Members also tend to argue for their initial position rather than being open to others' perspectives (Mojzisch & Schulz-Hardt, 2010). Groups also tend to form a consensus before discussing all of the information, which often leads to satisfactory but not optimal choices (Kerr & Tindale, 2004; Stasser & Titus, 1985). In addition, inappropriate shared representations can influence members away from normatively correct positions they initially held (Tindale et al., 1996). However, groups and their members do learn and sometimes they learn even in less than optimal situations. In addition, under the right circumstances, groups can be powerful learning environments.

Learning in groups is often described as the process of group-to-individual transfer (Laughlin, Carey, & Kerr, 2008; Laughlin, 2011). It assumes that if members learned how to solve a problem while working in the group, they should be able to solve the problem on their own after leaving the group. Laughlin (2011) describes two types of transfer: specific transfer, in which members can now solve the same problems that were solved by the group, and general transfer, in which members can solve similar but new problems that were not initially solved by the group. Although both types of transfer can indicate learning, general transfer is usually considered the more important type of learning because it can be used in future problem-solving endeavors. Laughlin (2011) also distinguishes between complete and partial transfer, in which complete transfer implies that members can now perform as well as their group did.

Another key concept for understanding group learning, again developed by Laughlin (1980; Laughlin & Ellis, 1986), is demonstrability. Laughlin (1980) argued that there is a continuum along which group tasks can be located with the endpoints defined as intellectual versus judgmental. Intellectual tasks are those in which group members can *demonstrate* the correctness of a particular solution during group discussion (e.g., math story problems). Judgmental tasks do not allow for such demonstration, and thus differences among members are often resolved based on how many members favor each alternative (e.g., majority wins). Laughlin and Ellis (1986) defined four conditions necessary for demonstrability to exist: a conceptual system for solving the problem is shared among the group members; available information is sufficient for solving the problem; all members understand the conceptual system; and members with correct solutions have the ability, time, and motivation to use the conceptual system to demonstrate the correctness of their choice. Laughlin (2011) argues that the ability to demonstrate the correctness of a response underlies both why groups tend to outperform

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individuals and why group-to-individual transfer, particularly general transfer, occurs. Obviously, group discussion and interaction are necessary for demonstration to occur.

Much like members of noninteracting groups, as long as member preferences are shared at some point in time, members of interacting groups can learn how their positions compare to others and whether they are normative (e.g., in the majority) or deviant. Interacting groups can also learn from outcome feedback, and the group discussion can aid in this learning. A number of studies have shown that groups learn to play economic games rationally much faster than individuals (Bornstein, 2003; Insko et al., 1994). For example, Fahr and Irlenbusch (2011) showed that groups were far better than individuals at learning to ignore specific instance feedback when it went against more general data trends. Kagel and McGee (2016) found that groups playing many rounds of a prisoner's dilemma game would shift their strategy toward cooperation when feedback suggested that cooperation risks were beneficial. Tindale et al. (2006) also found that groups were more sensitive than individuals to changes in payoff structure for games. Thus, as feedback and environmental conditions change, groups seem quite capable of adapting their behavior to fit the conditions.

Unfortunately, environmental feedback can be both variable and incomplete. Einhorn and Hogarth (1978) showed that in many decision-making situations, feedback on decision accuracy only occurs for the chosen option (e.g., people who are hired as opposed to those not hired). Under such conditions, feedback can be misleading. However, there is some evidence that groups can learn from feedback even under less than optimal circumstances. Tindale (1989) compared individuals and groups on a multicue decision task (promoting low-level managers into middle-level positions). Initial practice rounds were designed to instill a conservative (do not promote) decision bias, while in the main decision set (48 candidates) approximately half deserved promotion. Individuals and groups received either no feedback, feedback after promotion decisions, or feedback after all decisions. Groups quickly learned to reduce the conservative bias in the total feedback condition and also greatly outperformed individuals. In the no-feedback condition, neither individuals nor groups improved much over trials. However, in the partial feedback condition, groups slowly reduced the conservative bias and were performing almost as well as the total feedback groups by the last set of trials. It appeared that groups would occasionally choose to promote a less-than-stellar candidate and then receive positive feedback that it was the correct decision. Thus, groups slowly reduced their false-negative decision errors even under suboptimal feedback conditions.

The greatest advantage for fully interacting groups as compared to more restricted types of interaction is that members can share their knowledge and the rationales behind the positions they support. In other words, full interaction allows demonstration to be used to resolve preference difference among the group members. Laughlin (2011) has argued that demonstration is what allows correct minorities to overpower incorrect majorities so that groups will outperform individuals. Much of the evidence behind his argument stemmed from findings that the influence processes in problem-solving groups could be well represented by a "truth supported wins" model (Laughlin, 1980). Laughlin (2011) has

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shown that this model fits well for many different types of decision problems that fall near the intellectual end of the intellectual–judgmental continuum. Although truth supported wins is consistent with demonstration as a conflict resolution strategy, the model fit does not address whether demonstration was actually used. However, a number of recent studies have shown that groups that perform well tend to lead to member learning and that demonstration is a key component.

Olivera and Straus (2004) had individuals work on intellectual puzzles and then had them participate in a group working on the same puzzles, observe a different group work on the puzzles, or simply work on the puzzles again as individuals. Finally, they assessed learning by having individuals work on a related set of puzzles. Participants that either worked in or observed groups showed improvement in their ability to solve the puzzles relative to their initial performance, whereas individuals working alone showed no such improvement. Olivera and Straus also measured a number of cognitive (task information, strategy discussions, etc.) and social (approval, joking, etc.) aspects of the groups and found that the cognitive aspects of the group interaction produced the better performance. Curseu, Meslec, Pluut, and Lucas (2015) looked at group-to-individual transfer on a series of decision tasks and also measured individual members' level of "rationality" in terms of normative decision-making strategies. For groups that performed well, there was strong evidence for group-to-individual transfer, and the size of the difference was associated with improved cognitive decision-making strategies of the initially less able group members. Thus, participating in a group where other members could demonstrate the correctness of a particular alternative allowed less able members to learn the correct or rational approaches to the decision problems.

With such solid evidence that groups resolving member preference differences through demonstration leads to learning and better group performance, it remains puzzling why there is not more evidence in the literature for group-to-individual transfer. Although many situations find some transfer, rarely is it complete, and in some cases it is nonexistent (Stasson, Kameda, Parks, Zimmerman, & Davis, 1991; Tindale, 1993). One reason may be the difficulty of accurately recognizing member expertise. Although Bonner and Baumann (2012; see also Baumann & Bonner 2011) have shown that groups can incorporate member expertise into their decision making, it is often not weighted optimally. Also, groups typically rely on perceived expertise to guide their decision making, and there is not a one-to-one relationship between actual and perceived expertise. Littlepage et al. (1997) found that members tended to rate the expertise of other members as a function of how much they talked during discussion, yet the correlation between talking and actual expertise was virtually nonexistent. Bonner and Baumann (2012) also showed that without an intervention to help groups recognize their expertise, member extroversion was a better predictor of perceived expertise than was actual expertise.

It is also the case that, although groups can use demonstration, they often do not. Aramovich and Larson (2013) looked at five-person groups solving simple math problems and coded the group discussions for evidence of different types of consensus processes

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(demonstration, voting or majority wins, etc.). They found that groups that had a majority of correct members used demonstration less than 50% of the time, and the greatest use of demonstration (75%) occurred when only two members had the correct solution. When groups had only one member with a correct solution, demonstration was only used 50% of the time—a drop of 25% compared to the two correct member groups. This finding helps to explain why simply having a single correct member often does not lead to correct group judgments since single correct members were less likely to try and demonstrate the correctness of their response. It also helps to explain why transfer is often less than complete. When groups had a four-person majority of correct members, they rarely demonstrated the correctness of their choices to the lone incorrect member. Fortunately, the researchers also found that providing a goal of using demonstration to the groups substantially increased its use. Similar results have been found for providing goals for information sharing in groups (Van Ginkle, Tindale, & Van Knippenburg, 2009).

Summary and Conclusions

We have summarized the literature on group decision making with a focus on how learning could and does occur while groups are deciding. We have argued that groups and their members can learn, at least to some degree, with any of the various group decision procedures we described. Learning can occur from simply knowing that others either agree or disagree with one's position, and often knowing the final aggregated group position can lead members to make more accurate decisions. Another general finding is that environmental feedback is critical to learning, especially for those procedures that limit group member interaction. Finally, we have found that fully interacting groups have the greatest potential for learning, and such procedures typically do lead to learning, if often less than optimally so.

We would like to close with a description of what we feel would be the optimal conditions for group to learn while deciding. Many of the key ingredients are specified in Laughlin and Ellis's (1986) definition of demonstrability. First, a certain amount of shared background knowledge in the domain of interest is necessary for group members to learn from each other and from whatever feedback they receive. Without such shared knowledge, members may not be able to understand the arguments put forth by other members during the consensus process. However, diversity of knowledge and opinion within the group is needed for learning to occur. If all knowledge and information are shared among the group members, there will be quick consensus and little discussion, even if the consensus is for suboptimal position (Stasser & Titus, 1985; Tindale, 1993). Group members also need to have the time and the motivation to both present their ideas and (especially) to listen to the ideas of others. A recent study by Mellers et al. (2014) found that over and above high levels of motivation and cognitive/analytic skills, a key predictor of how accurate groups were in making forecasts was members' open-mindedness. If members were willing to listen to others and change their individual forecasts based on the arguments of these people, the groups made better forecasts. This also assumes that members feel comfortable enough to share their ideas with the rest of

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the group. Recent research has also shown that trust is a key variable for information sharing in groups (Van Ginkel, Tindale, & Van Knippenberg, 2009), and groups made up of members with prosocial orientations tend to perform better than groups with competitive or pro-self members (De Dreu, Nijstad, & van Kippenburg, 2008).

Research has shown what is needed in decision-making groups in order for learning to take place, but more research should be focused on how to ensure that such conditions are met. It may be time for group decision researchers to begin paying attention to the work on learning in student groups to see how interventions in that domain may be useful to decision-making groups as well. Decision making is almost always better in groups, and learning almost always makes for better decision making. Thus, research attempting to ensure the appropriate mix of group members, environment, and feedback should be a fruitful endeavor.

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