IT Support for Reducing Group Judgment Biases

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Abstract

Systematic biases have been found in both individual and group judgments, calling for research into debiasing approaches. Although individual debiasing has been studied to some extent, no parallel effort exists for group debiasing. This paper advocates the use of group support systems (GSS) for group debiasing and presents a theoretical perspective on how the impact may be achieved. Special attention is paid to two important judgment biases: representativeness bias and availability bias. A research model is developed, based on which propositions are derived.

1. Introduction

The seminal work of Amos Tversky and Daniel Kahneman [1974] has shown that human judgments contain systematic biases as a result of the use of heuristics. Decision makers employ heuristics so that complex inference tasks can be reduced to more manageable proportions. Two important heuristics are representativeness and availability [Kahneman and Tversky, 1972; Tversky and Kahneman, 1973, 1974]. Representativeness bias refers to the bias incurred in posterior-probability estimations by not properly utilizing information sources such as base rates; availability bias refers to the phenomenon that the frequency or probability of events is estimated by the ease with which instances or associations come to mind. Group judgments, an important facet of organizational activities, are also prone to these biases. Although debiasing methods and effectiveness have been examined in contexts involving individuals making judgments (e.g., [Elsasser, 1989; Wright, 1983]), no parallel effort seems to exist for group judgments.

Group support systems (GSS) have been designed to support group decision-making and deal with process losses, such as air-time fragmentation, conformance pressure, etc. Although GSS has been evaluated using various criteria, if and how well it serves as a debiasing tool remains unexplored. Possibly owing to this neglect, both the design and evaluation of GSS have been characterized by a tilted emphasis toward the communication perspective, and relatively fall short in terms of supporting the cognitive aspect of judgment and decision making processes. For example, the meta-analysis conducted by Benbasat and Lim [1993] shows that much empirical work in GSS has been more concerned with the collective and group communication phenomena than the cognitive and information processing aspects. However, as emphasized by DeSanctis and Gallupe [1987], more sophisticated GSS designs should incorporate not just communication, but modeling support as well.

This paper seeks to provide a theoretical perspective for the investigation of the impact of GSS on group judgment biases (with specific attention paid to representativeness bias and availability bias), by identifying the match between (new or existing) GSS group debiasing tools and judgment tasks. We believe that this research will fill an important gap in both the GSS literature and the literature in judgment heuristics and biases. More importantly, it will serve to open up a new direction for GSS research which is more closely associated with the investigation of traditional decision theories.

2. Two-Dimensional Information Integration Perspective

This research employs a top-down approach in attempting to theorize the effects of GSS on judgment biases. At the highest level, it uses a two-dimensional information integration perspective (TIIP) depicted in Figure 1. According to this perspective, the effect of GSS use on group judgments and choices is produced via two integration processes. Along the interpersonal dimension, GSS brings together the views, opinions, judgments and choices of individual members. The means by which the interpersonal aspect of information integration is accomplished is communication, which has been the traditional focus of GSS design and evaluation. Left unsupported, group processes are often plagued by...
"process losses", which refer to aspects of the meeting process that impair outcomes relative to the efforts of the same individuals working by themselves or those of groups that do not experience them [Steiner, 1972]. An example of process loss is "air time fragmentation", which refers to the need to partition speaking time among speakers during a verbal meeting [Nunamaker et al., 1991]. By incorporating electronic communication, GSS helps to reduce process losses such as air-time fragmentation through providing features such as parallel inputting, and forges a group judgment that takes into account a broader range of possibilities and considerations.

Although much of the GSS research has concentrated on the communication perspective, an equally important mechanism through which GSS may be useful in judgment and decision-making situations has to do with the more direct linkage between GSS and judgment tasks. This aspect involves cognitive support, dealing with the *intrapersonal* dimension of information integration. It is a well-known and undisputed fact that humans are limited in terms of cognitive processing capabilities. Correspondingly, decision aids should always be welcomed [Hogarth, 1980]. This aspect of GSS support has been relatively unexplored, although exceptions can be found (e.g., [Sengupta and Te’eni, 1993]).

For the sake of improving clarity in this discussion, the two dimensions have been conceptualized as though they were independent and orthogonal; however, in practice these dimensions may be intertwined; one activity may trigger the other, and vice versa. For example, through sharing of information and views, individuals may obtain new information, and thus trigger a new round of intrapersonal information integration. Similarly, after an individual has combined different information sources and arrived at a judgment, he might share it with the group, thus affecting the interpersonal information integration process.

In sum, two types of support can be provided by GSS to address the two aspects of information integration encountered in group judgment situations (see Figure 2). On the one hand, GSS provides features that improve communication among group members, thus making the group more efficient. The use of an efficient group (i.e., one that is devoid of "groupthink" and other deficiencies) has been proposed as a method in and by itself for improving judgments (e.g., [Janis and Mann, 1977; Libby, 1981]). GSS addresses communication problems by providing parallel communication and a communication channel that invites less social and political cues. On the other hand, GSS may also provide features that aim directly at augmenting the information processing capacity and capability of human decision makers, thus replacing the less reliable heuristics.

### 3. Components of GSS

Although different implementations of GSS may contain different decision and communication aiding tools, some generic GSS tools may be defined conceptually. Nunamaker et al. [1991] have identified four categories of tools that support the different group activities: (1) exploration and idea generation, which includes electronic discussion besides brainstorming; (2) idea organization, for organizing ideas into specific categories; (3) prioritizing, which support the evaluation of multiple items; and (4) tools that provide formal methodologies to support policy development and evaluation (e.g., stakeholder analysis).

Whereas this categorization is useful for many decision making situations, we propose that for judgment situations, which conceptually precede the choice phase, a more specific set of tools can be defined. Building on Nunamaker et al.'s taxonomy, we propose that for judgment situations, the following categories of GSS tools are needed: (1) *information exchange*, which primarily refers to electronic discussion; (2) *idea generation*, which specifically refers to electronic brainstorming; and (3) *problem-representation tools*, aimed specifically at debiasing and supporting a certain class of judgment tasks. The separation of idea generation from information exchange is also supported by Nagasundaram and Dennis [1993], who contend that:

"a large part of idea-generation behavior in electronic brainstorming (EBS) can be explained by viewing EBS as an individual, cognitive (rather than a social) phenomenon from the human information processing (IPS) perspective. EBS incorporates a set of structuring mechanisms meant to overcome the limitations of the human IPS. Consequently, a group using an EBS outperforms both verbal brainstorming and nominal groups by operating not as a group but as a collection of individuals who interact with an evolving set of ideas rather than with individuals.” (p.463).

Among the GSS components we propose for supporting judgment, electronic communication is perhaps the most familiar concept in GSS research, and has correspondingly received the most attention. Problem representation is a relatively new concept in GSS research, although it has been studied in the context of supporting individual judgments and debiasing.

### 4. A Match of GSS Tools and Judgment Tasks

"The decision-theory model recognizes two distinct components: judgment and risky choice; the latter is where judgments are combined with utilities for outcomes to determine action choices [Libby, 1981].
Judgment Tasks

This section describes two of the most prevalent judgment biases: representativeness and availability. These biases are also exemplars of distinct categories within the task taxonomy proposed by Hastie and Park [1986].

Representativeness bias. When the representativeness heuristic is used, the probability that X came from Y is evaluated based on how much X resembles Y. In other words, class membership of an object is judged by its similarity to the stereotypical class member. The use of this heuristic leads to several systematic biases in probability estimation. These include insensitivity to prior probabilities (i.e., the base-rate fallacy); insensitivity to sample size; misconceptions of chance; insensitivity to predictability; illusion of validity; and misconceptions of regression [Tversky and Kahneman, 1974]. The base-rate fallacy, of particular concern to this research, refers to people's tendency to ignore base rates in favor of individuating or specific information, rather than integrate the two [Bar-Hillel, 1980]. To illustrate, let us consider the following "cab problem" [Tversky and Kahneman, 1982], one of the most well-known problems in base-rate fallacy research.

"A cab was involved in a hit-and-run accident at night. Two cab companies, the Green and the Blue, operate in the city. You are given the following data:

(i) 85% of the cabs in the city are Blue and 15% are Green.
(ii) A witness identified the cab as Green. The court tested the reliability of the witness under nighttime visibility conditions and concluded that the witness correctly identified each one of the two colors 80% of the time and erred 20% of the time.

What is the probability that the cab involved in the accident was Green rather than Blue?"

The correct answer is 41%, but the most commonly given answer is 80% due to subjects' over-reliance on the diagnostic information. The representativeness bias is found not only in individual, but group judgments as well. For example, Argote, Seabright, and Dyer [1986] found the bias to be more severe in group judgments than in individual judgments, suggesting an obvious need for some type of support. Argote, Devadas, and Melone [1990] found the tendency for groups to be more ignorant about base rates than individuals when the individuating or diagnostic information is informative rather than vague. Consistent with these findings, Brightman et al. [1983] reported that nominal groups behave more like Bayesian information-processors than interacting groups. Interested in the group consensus process, Stasson et al. [1988] used the social decision scheme approach to study two representativeness tasks. For one task, the group consensus process can be described with a model suggesting groups to be only slightly better than individuals; for the other task, the best fitting models correspond to indications that groups have a higher proportion of biased decisions than people working individually. In general, empirical studies have found more severe biases in group judgments than in individual judgments.

Availability bias. When the decision maker uses the availability heuristic, the frequency or probability of occurrence of an event is judged by the ease with which similar events are brought to mind. For example, one may assess the risk of heart attack among middle-aged people by recalling such occurrences among one's acquaintances. This results in biases due to retrievability of instances. Similarly, one may evaluate the probability that a given business venture will succeed or fail by imagining various difficulties it might encounter. This results in biases due to imaginability. Resulting biases due to retrievability of instances and biases due to imaginability have important potential consequences for business judgments. When we judge the probability of events we have previously experienced, sensational and vivid events are more easily remembered. Overestimation of the probability of these events and underestimation of less spectacular events often result. In fact, selective bias due to the use of the availability heuristic has been specifically pointed out by Janis [1982] as a major defect in decision-making.

An example of the problems employed in availability research is to ask subjects to estimate the relative frequencies of appearance of a certain letter (e.g., "R") in the first and third positions in English words [Tversky and Kahneman, 1973]. Despite the fact that the tested letters are more frequently found in the third position, a large majority of subjects judged the first position to be more likely, as a result of the corresponding words being more available to recall. Much of the availability research, however, does not involve a direct measurement of the degree of availability. Forbringer's [1991] study makes a useful exception. Forbringer [1991] examined whether job perceptions as measured by the Position Analysis Questionnaire (PAQ) [Mecham, McCormick, and Jeaneret, 1977] were affected by the availability heuristic. The availability of PAQ items were evaluated by 202 subjects using four measures of availability: familiarity, meaningfulness, vividness, and ease of example generation. Based on these availability ratings, items were placed in one of three categories: low, medium, or high. Independent samples of subjects analyzed four jobs (insurance underwriter; building maintenance man; insurance claims superintendent; and secretary) using the PAQ. It was hypothesized and found that PAQ items which were rated as being more available produced significantly different ratings than those rated as being less available, irrespective of jobs. The effect of the availability heuristic on job perceptions was thus strongly established.

Following Lichtenstein et al. [1978] who studied
availability bias in an individual context, Sniezek and Henry [1989] asked their subjects, in individual and group settings, to estimate the frequencies of some causes of death. The researchers found groups judgments to be more accurate than individual judgments, although bias was still present in group judgments. These results were replicated by Sniezek and Henry [1990] with a comparable task. Stasson et al. [1988] examined the group consensus process in an availability task. The task required participants to estimate the relative frequencies of appearance of the letter "R" in the first position of a word versus the third. The best-fitting model indicates that the availability bias can be attenuated with GSS by providing some sort of problem representation tool. On the other hand, availability bias is primarily rooted from an inefficient information search, and thus can be addressed using the electronic brainstorming tool. It should be pointed out that in comparison, the electronic brainstorming tool is a more generic GSS tool than the problem representation tool, which has to be tailored to specific classes of problems.

**Problem representation.** Previous research has pointed out the effect of problem representation on the neglect of base rates (e.g., [Gigerenzer, Hell, and Blank, 1988]). Roy [1991] went a step further in identifying the underlying cognitive processes that may explain such effect. Based on empirical data, they concluded that causal representations dominate information processing in base rate problems. In such representations, for example, a causal link is formed between the event "the cab was green" and the event "the witness says the cab was green", such that the former causes the latter. Related to this internal representation, semantic confusion of different types of conditional probabilities has been observed [Dawes, 1986; Eddy, 1982]. For example, when questions are posed in an inverse-to-causal order (e.g., If the witness says the cab was green, what is the probability that it was in fact green?), people tend to reinterpret the question to fit the causal order (i.e., If the cab was green, what is the probability that the witness says it was green?). However, when no causal links are present in the representation, judgments are more accurate, or closer to the normative answer [Bar-Hillel, 1980; Roy, 1991]. Because no causal theory can be derived, people resort to feature similarity for categorization. Using the cab problem [Tversky and Kahneman, 1982], for example, the representation would involve the following categories: green cab identified (by witness) as green; green cab identified as blue; blue cab identified as blue; blue cab identified as green.

Following from the above, a promising approach to improve judgments in base-rate fallacy-generating contexts would be to help people build non-causal representations. Previous results have shown that representing the problem situation in terms of the population distribution, and visualizing the characteristics of the various components facilitates judgments of probabilities [Christensen-Szalanski and Beach, 1982; Pollatsek et al., 1987]. In particular, tables and graphics have been tested as representational aids (e.g., [Cole, 1989]). Roy [1991] concludes that a table is not sufficient to change the initial causal representation of the problem, and that graphs present the interaction of object features more clearly. Roy further recommends graphical representational aids as critical elements in decision support systems (DSS) design for probabilistic reasoning.

Part of the current research represents a further extension on the study of problem representation as a debiasing tool. In availability task, by incorporating into GSS a graphical problem representation tool known as "probability map" [Cole, 1988, 1989; Roy, 1991] to help in improving group judgments (see Figure 3).

The map consists of a total of 100 boxes, which are differentiated both in terms of base rate and diagnostic information. For example, Figure 3 shows a situation where the base rate is 85% lawyers and 15% engineers, and the diagnostic information is such that correct identifications based on personality profiles are made 80% of the time (thus errors are caused 20% of the time). Therefore, 85 of the 100 boxes are colored white and the other 15 boxes shaded. Out of the 85 boxes representing lawyers, 17 are crossed, denoting the fact that 20% of the 85 are (correctly) identified as engineers. Also, out of the 15 boxes representing engineers, 12 are crossed, since 80% of the 15 are (correctly) identified as engineers. Consequently, if one is interested in the probability that a certain personality profile has been correctly identified as engineer, such probability can be easily derived by differentiating among the different types of boxes.

**Electronic brainstorming.** In availability task,

2 Other possible representations that have been suggested include "signal detection curve" and "disease detection bar" [Cole, 1989].
judgment biases are caused by, among other things, limited information search sets. Correspondingly, the GSS tool necessary to provide cognitive support is the idea generation, or electronic brainstorming, tool.

The general principle underlying many idea generation methods is to create sources of variety in a participant's environment - the greater the variety in the sources (or stimuli) of ideas, the greater the potential variety of ideas generated [Hoffman, 1959]. However, in unaided brainstorming situations, cognitive limitations of human as an information processing system (IPS) [Newell and Simon, 1972] severely restrict the productivity of the technique. By providing cognitive assistance to the IPS, electronic brainstorming has been found to be more effective than either verbal brainstorming [Gallepe et al., 1992] or nominal group idea generation, where individuals work separately without communicating [Dennis and Valacich, 1993; Gallupe, Bastiaannatti, and Cooper, 1991; Gallupe et al., 1992; Valacich, Dennis, and Connolly, 1994].

An electronic brainstorming system includes three structuring mechanisms - parallel input, collective memory, and serially retrievable output - that together work around the limitations of the IPS [Nagasundaram and Dennis, 1993]. The parallel input mechanism allows participants to contribute ideas as soon as they are generated. Thus, participants need not rehearse their ideas in short-term memory indefinitely, and their short-term memory can be freed up for processing additional ideas. Nonetheless, ideas generated simultaneously by multiple participants cannot all be attended to and committed to memory by participants because of the serial nature of the IPS. To address this limitation, the collective memory mechanism allows these ideas which have been generated in parallel to be stored and later retrieved by a participant at will from this external memory. The serially retrievable output mechanism permits ideas to be accessed one at a time in any sequence unrelated to the sequence in which they were generated. Furthermore, the collective memory helps decouple the parallel input from the serial output, and introduces at least one level of indirection of communication among group members. These three mechanisms together create the necessary and sufficient conditions for production "unblocking" to occur [Nagasundaram and Dennis, 1993]. "Production blocking" refers to the phenomenon that ideas and comments are suppressed due to cognitive limitations, and may be further differentiated as attenuation, concentration, and attention blockings [Nunamaker et al., 1991]. Attenuation blocking occurs when group members who are prevented from contributing comments as they occur, forget or suppress them later in the meeting, because they seem less original, relevant, or important. Concentration blocking refers to the phenomenon that fewer comments are made because group members concentrate on remembering comments (rather than thinking of new ones) until they can contribute them. Attention blocking is encountered when new comments are not generated because group members must constantly listen to others speak and cannot pause to think. Each of these aspects can be effectively dealt with using the structuring mechanisms of the electronic brainstorming system. In several recent studies, groups which brainstormed electronically have been found to outperform verbally brainstorming and non-electronic nominal groups in the number of ideas generated [Dennis and Valacich, 1993; Gallupe, Bastiaannatti, and Cooper, 1991; Gallupe et al., 1992; Valacich, Dennis, and Connolly, 1994].

Electronic Communication

It should be obvious that the GSS tools identified above are meant to support the intrapersonal aspect of the information integration process. A key difference separating group decision and judgment process from its individual counterpart is the fact that group decision and judgment occurs as the result of interpersonal communication - the exchange of information among members [DeSanctis and Gallupe, 1987]. The group decision process is revealed in the production and reproduction of positions regarding group action, which are directed toward the convergence of members on a final judgment or choice [DeSanctis and Gallupe, 1987]. The communication activities exhibited in a decision- or judgment-related meeting include expressions of preference, argumentation, socializing, information seeking, information giving, and solution development [Bedau, 1984; Poole, 1983]. With GSS, these activities may be supported with electronic communication.

The difference between electronic communication and verbal communication has been viewed from different perspectives [Lim and Benbasat, 1993]. For example, F. Lim and Benbasat [1991] point out that the two communication channels differ in terms of "paths" and "contents". The electronic communication channel takes a somewhat indirect and longer path than the verbal channel, since any group member's input has to go through the computer system before reaching the target recipient. However, given the very high speed of transmission rate of electronic communication, this difference is transparent at the user level. A second difference has to do with the fact that electronic communication contains fewer social and political cues, and is therefore relatively task-oriented. In comparison, verbal communication channel supports socio-oriented communication better by accommodating verbal cues such as timing, pauses, accentuations, tonal inflections, etc. This distinction is supported by the findings of empirical research [Hiltz and Turoff, 1978; Rice, 1984] and consistent with the concepts of the media richness theory [Daft and Lengel, 1986].

Two distinctions between electronic communication and verbal communication are of particular relevance to this research. First, the "social presence" of the electronic
communication channel is lower than that of the verbal communication channel [Rice, 1992]. "Social presence" is the degree to which a medium is perceived as conveying the actual physical presence of the communicating participants [Short et al., 1976]. This social presence depends not only on the words conveyed during communication, but also upon a range of nonverbal cues including facial expression, direction of gaze, posture, attire, and physical distance and many verbal cues (timing, pauses, accentuations, tonal inflections, etc.) [Birdwhistle, 1970]. Because of the lower social presence in electronically-communicating groups, group members need not be as sensitive or wary in making suggestions that seem to be in opposite directions to those made by others. Indeed, electronic communication is capable of facilitating free expression of views and opinions, a desirable element of group process [DeSanctis and Gallupe, 1985; Harrobaugh, 1990].

Second, the parallel communication made possible by the electronic communication channel allows group members to raise their thoughts and comments simultaneously, without having to wait for another person to finish speaking [Zigurs, 1988]. Consequently, process losses such as air-time fragmentation are reduced, and the interpersonal information integration is improved.

The major difference between the electronic communication tool and the electronic brainstorming tool is that the intent and design of the former has a distinct cognitive focus [Nagasundaram and Dennis, 1993], whereas the focus of the latter is primarily social. Indeed, Easton, George, Nunamaker, and Pendergast [1990] found, when comparing electronic discussion tool to electronic brainstorming tool, that the number of ideas generated is significantly lower when using the former. This finding was traced to the fact that while the primary purpose of the electronic communication tool is to help in the convergence of views and opinions, the electronic brainstorming tool is designed to encourage divergence of ideas. Easton et al. concluded that each tool worked best on the task for which it was designed, thus supporting the premise that there should be a match between the GSS tool and the aspect of the information integration process to be supported.

The concept of viewing the effects of GSS use in terms of cognitive and information-exchange aspects parallels that of viewing the effects of negotiation support systems in terms of decision and communication aids [Lim and Benbasat, 1993].

5. Research Model

The impact of GSS should be examined in terms of both judgment processes and judgment outcomes (see Figure 4). The exploration of the judgment processes provides insight into why the outcomes occur as they would. The detailed variables vary according to the judgment tasks so as to cater to the specific aspects of process and outcome pertaining to each task.

Representativeness Bias

The cognitive support in this case is realized in the form of the problem representation tool. The impact of GSS on the judgment process can be measured by five variables, aimed basically at understanding the integrating process of the two relevant pieces of information, i.e., diagnostic information and base rate. "References to the use of single information source" reflects the group's resolution involving only one piece of information, which is obviously biased. On the other hand, "references to the use of dual information sources" refers to the group's use of two pieces of information, while they may or may not be properly combined. "References to the use of the problem representation tool" is a measure of how often the group refers to the support tool, and thus is only meaningful within groups provided with the tool. Judgment bias, an outcome measure, is assessed as the difference between the group's response and the correct solution given by the Bayesian model.

Availability Bias

The cognitive support in this case is realized in the form of the electronic brainstorming tool. Six process variables, aimed basically at understanding how the information search scope is affected, are included. "Number of positive ideas mentioned during discussion" refers to the total count of ideas mentioned during discussion in support of the issue at hand. In contrast, "number of negative ideas mentioned during discussion" refers to the total count of ideas mentioned during discussion in refutation of the importance of the issue at hand. "Number of ideational connections with ideas generated during electronic brainstorming" measures the degree to which ideas generated during electronic brainstorming are used during subsequent discussion. "Number of ideational connections with ideas mentioned during earlier discussion" measures the degree to which ideas mentioned during earlier discussion are used in later deliberations. "Number of specific proposals of estimates" measures the total number of times an estimate of the frequency of occurrence or importance of the issue at hand is proposed; this variable is useful for the availability task since the availability bias is usually encountered in situations requiring the estimating of the frequency of
occurrence or importance of events. "Availability bias" is a direct measure of the judgment bias itself, operationalized as the difference between scores (i.e., estimates) assigned to a set of high-availability items and those assigned to a comparable set of low-availability items.

6. Propositions

We present in this section two major propositions concerning the impact of GSS on judgment biases and the processes through which bias reduction is achieved. Detailed hypotheses may be derived from these propositions.

Proposition 1: Judgment biases will be reduced in groups provided with cognitive support (vs. no cognitive support) or electronic communication (vs. verbal communication).

The relative effectiveness of these two GSS components will depend on the differential responsiveness of the particular type of judgment being addressed to the two dimensions of information integration, i.e., interpersonal vs. intrapersonal. For example, electronic communication is useful when the judgment task is constrained by both intrapersonal and interpersonal aspects of information integration, and can be helped by improving either of the aspects. Availability task, a memory-based task, falls in this category, because availability bias is primarily associated with limitations in the information search scope, which can be expanded either through providing cognitive support to individual group members or via information sharing among group members. Electronic communication aids the latter. On the other hand, when the judgment task is restricted mainly by information processing capacity of group members and benefits little from information exchange among them, the usefulness of electronic communication is limited. This is the case with the representativeness task. In fact, the representativeness bias has been found to be greater in (unaided) group judgments than in individual judgments [Argote et al., 1986, 1990; Brightman et al., 1983; Stasson et al., 1988].

Proposition 2: GSS will achieve the desired bias reduction through influencing the judgment process in a particular manner, depending on the judgment tasks.

To illustrate, consider the use of problem representation tool (cognitive support) in addressing the representativeness bias. Base-rate fallacy has been caused by an over-reliance on the diagnostic information (versus base rate) both in individual and group judgment situations [Argote et al., 1990; Bar-Hillel, 1980]. The problem representation tool offers a radically different way of viewing the information sources, thus highlighting the saliency of the base rate to group members. Consequently, we expect groups provided with the tool to make fewer references to the diagnostic information and more to the base rate than groups not provided with the tool.

At the same time, because the problem representation tool produces a representation that takes into account both the base rate and the diagnostic information, groups provided with the tool are expected to make fewer references to the use of a single information source than those not provided. From an information integration perspective, the base-rate fallacy is a direct consequence of groups not properly combining the relevant information sources. In the extreme situations (inclusive of the base-rate fallacy), only one piece of information is utilized for generating the posterior probability.

Next, consider the case of the availability bias, which is a consequence of the limitations of the human information processing system. Events which are more available to the memory are also judged as more important or occurring more frequently. The primary function served by the electronic brainstorming tool in this situation is to enlarge the information search scope of group members and the group, thus increasing the total number of ideas generated and the connections of discussion to these ideas. The net result is a better and more thorough information search and integration, thus leading to reduced availability bias.

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Interpersonal Information Integration

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Figure 1. The two-dimensional information integration perspective

Cognitive Support → Intrapersonal Information Integration → Group Judgment
Electronic Communication → Intrapersonal Information Integration

Figure 2. GSS Components and the two dimensions of information integration
Figure 3. Problem representation tool

Figure 4. Research model