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Information Technology Support For Debiasing Group Judgments: An Empirical Evaluation

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Human judgments, made by either individuals or groups, have been found to contain biases. One of the most prevalent biases identified is the *availability bias*, associated with the phenomenon that events which are more available to human memory are correspondingly judged as occurring more frequently or as being more important. This paper is concerned with how to reduce the availability bias in the group context. It reports an experiment in which two computer-based support facilities, electronic brainstorming and electronic mail, were tested for their contributions to reducing the availability bias. A 2 × 2 experimental design was used: electronic brainstorming (available or not) and communication mode (electronic or verbal). Forty teams of three members each were asked to work on a task involving the rating of the importance of a number of items associated with a secretary's task. Both electronic brainstorming and electronic communication helped reduce the availability bias. In both cases, the reduction in bias was due to increased attention paid to items that were found to have low availability in the absence of these support tools.

Human decision makers are capacity-limited. As a consequence, they have been found to "satisfice" (Simon, 1957) and employ cognitive heuristics that

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would produce decisions and judgments efficiently (Kahneman, Slovic, & Tversky, 1982) though most often imperfectly (Kerr, MacCoun, & Kraemer, 1996). One such heuristic is availability. "A person is said to employ the availability heuristic whenever he estimates frequency or probability by the ease with which instances or associations come to mind" (Tversky & Kahneman, 1973, p. 208). The bias that is correspondingly produced is referred to as the availability bias. Group judgments, an important component of organizational decision making, are not immune to this type of bias (Sniezek & Henry, 1989; Stasson, Ono, Zimmerman, & Davis, 1988). Nevertheless, there is a lack of understanding on how to develop tools and techniques for group debiasing.

It is evident that studying group judgment and biases is a worthwhile endeavor given the many examples where groups are asked to make final decisions, such as juries, legislators, boards of directors, and project teams. Group judgment is a more complex process than individual judgment; consequently, there are many more ways things could go wrong within a group. Salient differences between individual availability bias and its group counterpart can perhaps be made most apparent by viewing judgment activities in terms of information integration processes (Kerr et al., 1996). In this regard, judgment processes at the individual level mainly deal with intrapersonal information integration and are bound by cognitive processing limitations. On the other hand, group judgment processes invoke an additional level of information integration—the interpersonal level. A group member needs to be concerned not only with how to come up personally with a good judgment, but also to communicate and collaborate with other members in order to arrive at a group judgment. Various computer-based tools could be designed to assist the interpersonal interaction among group members.

This research investigates the extent to which two support tools, electronic brainstorming (EBS) and electronic mail (EM), reduce group availability bias. Though they both facilitate a free expression and exchange of ideas and opinions by reducing "production blocking" and "evaluation apprehension" (Diehl & Stroebe, 1987), these tools are expected to play different roles in reducing availability bias. EBS builds upon group idea generation by incorporating automation and structuration into the process. It has been found to be more effective than verbal brainstorming (Gallupe, Dennis, Cooper, Valacich, Bastianutti, & Nunamaker, 1992) or nominal group idea generation, where individuals work separately without communicating (Dennis & Valacich, 1993). Its main role in this study is to enlarge the information search scope of the group as a whole by encouraging the divergence of ideas using a structured method. EM is an alternate medium to verbal communication. We do not expect, as observed by Easton, George, Nunamaker, & Pendergast (1990), for EM to be as effective as EBS in increasing the number of ideas generated. Rather, we expect the main contribution of EM to be the facilitation of the evaluation of the ideas generated, and, more specifically, the expansion of the scope of the solutions discussed, by allowing parallel exchanges and by creating a lower social presence.

This paper is organized as follows. The first section discusses the concept of

availability bias. The following section presents the theoretical perspective underlying this and proposes the hypotheses. Then the research method is described. The next section contains the statistical analysis of the experimental data. The last section discusses and interprets the research findings.

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 dying from a heart attack among middle-aged people as compared to other types of illnesses 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 the venture might encounter. This results in biases due to imaginability. These biases 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 such events and underestimation of less spectacular events often result. In fact, Janis (1982) has included as a major decision-making defect such selective bias due to the use of the availability heuristic.

An example of the problems employed in availability research is to ask participants to estimate the relative frequencies of the 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 participants judged the first position to be more likely, as a result of these words being more available to recall when they are in the first position of the word.

The focus of this research is on *group* judgment. While many empirical studies on group judgment biases exist, the review paper by Kerr et al. (1996) identifies only a single instance where the availability bias was studied in a group setting. Stasson et al. (1988) asked participants to estimate the relative frequencies of the appearance of the letter R in the first position of a word versus the third, i.e., the task described in paragraph above. Though groups (four members) outperformed individuals working alone, 54% of the individuals and 33% of the groups still displayed a judgment bias. In a task associated with the availability bias, Sniezek and Henry (1989), following Lichtenstein, Slovic, Fischhoff, Layman, & Combs (1978) who studied availability bias in an individual context, asked their participants, in individual and group settings, to estimate the frequencies of 15 causes of death. The researchers found group judgments to be more accurate than individual judgments (groups exhibited a 23.7% reduction in bias compared to individuals), although bias was still present in group judgments.

These findings suggest that availability bias observed in individuals can be only *partially* corrected using groups. Not only is there very little research on how groups are affected by this bias, there is none on how to alleviate them.

Therefore, the need to research this bias is important in itself and in addition has the potential to further our understanding of the efficacy of using computer-based tools for debiasing.

THEORETICAL MODEL

Information Search Scope and Solutions Design Scope

We will introduce two concepts for describing how to alleviate the availability bias: information search scope (ISS) and solutions design scope (SDS). Recall the example discussed earlier about determining the chances of one dying from a heart attack as compared to other illnesses. Expanding the information search scope, in this case, refers to recalling more examples of the kind of diseases that might lead to death. Expanding the solutions design scope refers to considering and assessing more fully the degree to which each of the diseases identified might, or might not, be fatal as compared to the others. To more clearly articulate the roles of these two concepts, we will first visit Simon's (1960) decision-making model.

The model encompasses three distinct phases: intelligence, design, and choice. During the intelligence phase, the decision maker searches the environment for conditions calling for decisions. In this stage, data are obtained, processed, and examined for clues that may identify problems or opportunities. During the design phase the decision maker generates (focus is on expanding the ISS) and evaluates (focus is on expanding the SDS) possible solutions. This stage involves processes to understand the problem, generate solutions, and test solutions for feasibility. Finally, during the choice phase, the decision maker evaluates, selects and implements an alternative from the set of potential solutions.

Consider the example of a manager working on the following problem: how to make the organization more successful. Linking this model to the processes of availability bias, we can imagine that during the design phase the decision maker first begins with searching within some limited scope the information that comes to mind, i.e., available. This information may include strategies for improving productivity, increasing customer demand, better product innovations, and the like. The size of this ISS will have a significant influence on the next steps. Specifically, it will affect the size of the scope of solutions developed and considered, i.e., SDS, that could include information about the factors that would lead to the success of each strategy and the evaluation of each strategy both in absolute terms and in comparison to others. With a smaller ISS, which results in a smaller SDS, the chosen solution is conceivably more biased than otherwise. In other words, if certain strategies were not considered in the first phase (ISS), they will not be evaluated in the subsequent one (SDS).

A mechanism that may prove effective in reducing availability bias has thus to do with the enlargement of both ISS and SDS. There is empirical evidence that individuals working alone manage to generate only a small portion of the potential solution domain (Connolly, Routhieux, & Schneider, 1993). Whereas

the formation of a group has the potential to influence the increase in scope, a natural, unaided group is usually plagued with many process losses, causing decision outcomes to be much less than optimal. One major process loss is "groupthink," which refers to "a mode of thinking . . . when the members' striving for unanimity override their motivation to realistically appraise alternative courses of action" (Janis, 1982, p. 9). The implication of this in the context of availability bias is that there will be a significant degree of *overlap* of those information sets (corresponding to the ISS) for the different members (a similar argument extends to the solutions sets, which correspond to the SDS). The resultant set is thus not much greater than any individual set. The reason for bringing in support tools is therefore to enlarge the resultant ISS and SDS for the group. To achieve these purposes, EBS and EM are each deemed suitable, based on the following deliberations regarding their contributions.

Electronic Brainstorming and Electronic Mailing

Structure of electronic brainstorming. Osborn (1957) introduced a systematic technique, in the form of a set of rules, to help increase the effectiveness of the brainstorming process in groups. The technique was found to increase the number of ideas produced (Lamm & Trommsdorff, 1973). However, the performance of nominal groups (i.e., noninteracting individuals) was found to be superior to verbally brainstorming groups (Lamm & Trommsdorff, 1973; Mullen, Johnson, & Salas, 1991).

Production blocking, a major factor affecting the difference in performance between verbally brainstorming and nominal groups (Diehl & Stroebe, 1987), occurs for one or more of three reasons (Diehl & Stroebe, 1991; Nunamaker, Dennis, Valacich, Vogel, & George, 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 members concentrate on remembering comments rather than thinking of new ones, until they can contribute them, as a result of short-term memory limitations. *Attention blocking* occurs when new comments are not generated because group members must constantly listen to others speak and cannot pause to think; in other words, exposure to others' ideas distracts or interferes with their thinking.

There is evidence that EBS can effectively address the process losses mentioned above. In several recent studies, groups which brainstormed electronically have been found to outperform verbally brainstorming and nonelectronic nominal groups in the number of ideas generated (Dennis & Valacich, 1993; Gallupe, Bastiannutti, & Cooper, 1991; Gallupe et al., 1992; Valacich, Dennis, & Connolly, 1994).

An EBS system includes three structuring mechanisms—parallel input, collective memory, and serially retrievable output—that together work around the limitations of the human information processing system (Nagasundaram & 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 human information processing system. 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 & Dennis, 1993), thus leading to the generation of more ideas from the group members. A larger number of ideas generated represents a bigger ISS.

In addition to the three structuring mechanisms described above, there is another characteristic of EBS that contributes to increasing the ISS. By virtue of allowing anonymous input of ideas, EBS facilitates the free expression of views and opinions, therefore reducing evaluation apprehension (Nunamaker et al., 1991). With the fear of conformance pressure and concerns of others' negative evaluation thus reduced, there will conceivably be a greater number of ideas contributed.

Structure of Synchronous Electronic Mailing. EM has become commonplace and replaces verbal communication in many work situations. Two distinctions between electronic communication and verbal communication are of particular relevance to this study. 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, Williams, & Christie, 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.) (Argyle, 1969; Birdwhistle, 1970). Because of the lower social presence in EM 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 & Gallupe, 1985; Harmon & Rohrbaugh, 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, and therefore production blocking, are reduced, leading to improved interpersonal information integration.

The features of synchronous EM provide conditions for the prevention of groupthink especially in the design phase of Simon's model. Members are less concerned about suggesting novel solutions, thus enlarging the group SDS.

Hypotheses

Effect of electronic brainstorming. Availability bias is a consequence of the limitations of the human information processing system. Events that are more available to the memory are judged as more important or occurring more frequently. The primary function served by the EBS tool is to remedy this situation by enlarging the ISS of each of the group members and the group as a whole by alleviating both production blocking and evaluation apprehension.

The EBS is designed to specifically encourage the divergence of ideas. EBS builds upon group idea generation by incorporating automation and structuration into the process that work around the limitations of the human information processing system (Nagasundaram and Dennis, 1993). This leads to a larger number of ideas generated, as observed by Easton et al. (1990). The net result is a better and more thorough information search and integration, and, as a consequence, reduced availability bias. We therefore hypothesize that:

Hypothesis 1. The availability of an EBS will lead to a greater number of ideas generated.

Hypothesis 2. The availability of an EBS will lead to lower availability bias.

Hypothesis 3. The number of ideas generated will mediate the effects of an EBS in lowering availability bias.

Effect of Electronic Communication. The main contribution of EM will be to facilitate the evaluation of the ideas generated and, more specifically, lead to the expansion of the scope of the solutions discussed, by allowing parallel exchanges and creating a lower social presence.

Synchronous EM, compared to verbal communication, reduces social presence and therefore evaluation apprehension. As a consequence, a group member is less concerned about making evaluations that contradict those made by others. Thus, by improving the interpersonal communication process, electronic communication is expected to reduce the extent of groupthink and facilitate the design of alternative solutions, expanding the scope of solutions considered and thus leading to lower availability bias. EM also allows parallel exchanges and provides a group memory; such advantages help to improve group interactions via reduction of production blocking (Zigurs, 1988), thus further encouraging the expansion of the scope of solutions considered.

Hypothesis 4. EM, as compared to verbal communication, will lead to a greater number of solutions proposed.

Hypothesis 5. EM, as compared to verbal communication, will lead to lower availability bias.

Hypothesis 6. The number of solutions proposed will mediate the effects of EM in lowering availability bias.

RESEARCH METHOD

Participants

Participants for the experiment, who volunteered for their participation, were graduate and undergraduate students at a west coast business school. One hundred twenty participants were randomly allocated to 40 three-member groups. Each participant received $30 upon completing the participation. Each individual in the best performing groups in each experimental condition received additional cash rewards of $50, $30, or $20 depending on group performance.

Gender composition was not a controlled variable in this experiment. Correspondingly, mixed-gender groups as well as same-gender groups were included.

Experimental Task

Background. The Position Analysis Questionnaire (PAQ) is a rigorously researched, and the most popular, job analysis instrument (for the development and history of PAQ, see McCormick, 1976). It is used to make discriminations between and among jobs, identify aptitude and ability requirements, identify job related experience and job interest requirements, develop job applicant interview criteria and performance appraisal standards, conduct job evaluation studies, and create career path models (Mecham, McCormick, and Jeanneret, 1977). PAQ consists of mainly worker-oriented items, such as "learning and recall," "contact with customers," and "attention to detail." In analyzing a job with the PAQ, the analyst rates the relevance of each item to that job.

Forbringer (1991) examined whether or not job perceptions as measured by the PAQ were influenced by the availability heuristic. The availability of PAQ items was evaluated (rated) by 202 raters using four dimensions of availability: familiarity, meaningfulness, vividness, and ease of example generation. This evaluation was done in the absence of a specific job context. Based on these ratings, items were placed in one of three availability categories: low, medium, or high. A new group of raters, different than the previous group of 202 participants, analyzed four jobs (insurance underwriter, building maintenance man, insurance claims superintendent, and secretary) using the PAQ. Forbringer found that PAQ items which were rated as being more available by the earlier group of 202 raters were rated by the latter group as significantly more relevant to any job than those rated as being less available. The effect of the availability heuristic on job perceptions was thus strongly established.

The experimental task. For this study, participants were asked to rate the relevance of eight PAQ items with respect to a secretary's job (see Table 1). Four are high availability items (items 2, 3, 6, and 8 in Table 1) and the other four are low availability items (items 1, 4, 5, and 7 in Table 1), based on

TABLE 1

PAQ Items Used

Items	Definition
1. Estimating speed of processes	Estimating the speed of ongoing processes or a series of events while they are taking place.
2. Use of job-related knowledge	The importance to job performance of specific job-related knowledge or information gained through education, experience, or training, as contrasted with any related physical skills.
3. Short-term memory	Learning and retaining job-related information and recalling that information after a brief time.
4. Hand-operated controls	Controls operated by hand or arm for making frequent but not continuous adjustments.
5. Personal contact with buyers (both inside and outside the organization)	I.e., purchasing agents, not public customers.
6. Attention to detail	A need to be thorough and attentive to various details of one's work, being sure that nothing is left undone.
7. Vigilance: Infrequent events	A need to continually search for infrequently occurring but relevant events in the job situation.
8. Written materials	The extent of use of written materials (e.g., books, reports, office notes, articles, job instructions, or signs).

Forbringer's (1991) findings. To confirm that these items would be perceived similarly by our pool of participants, we performed a manipulation check with 20 participants who did not participate in the actual experiment. The availability scores of the two groups of items were found to be significantly different ($t = 8.38$; $p < .01$) in the expected direction.

Forbringer's research shows that owing to availability bias, items highly available to memory are rated significantly more relevant to a secretary's job (and three other jobs) than those that have low availability. By including both high- and low-availability items in our task, we sought to show that the use of the computer-based tools would, through boosting the availability of (originally) low-availability items, reduce the erroneously large difference in ratings between high- and low-availability items.

Participants were asked to perform the task as a group. Agreements on ratings by group members were reached through group discussions and recorded on a form. Consistent with the PAQ instrument, the scale used ranged from 0 ("does not apply") to 5 ("extreme importance").

Research Design

A 2 × 2 factorial design was employed. The first factor, EBS, was either available or not. The second factor, Communication Medium, was either verbal or electronic. The baseline condition corresponds to the natural group setting, i.e., working without EBS and communicating verbally.

EBS allowed group members to generate ideas simultaneously about a particular topic. The facilitator initiated a session by typing in the topic and sending

out electronic forms to group members. Each group member received one form at a time, on which he or she could enter one idea. In this case the topic concerned a work-oriented item related to a secretary's job (see section on the experimental task for details); thus, participants used the tool to generate instances where they thought that item would be applicable. As an example, for short-term memory, i.e., "learning and retaining job-related information and recalling that information after a brief time"; an instance generated may be "receiving phone calls and passing on messages." In a way, therefore, this process served to force participants to discover associations between the item and the job that they might have otherwise not realized. The participant sent back the form once it was completed and received another form from the system; this process continued until a time limit was reached. The following points regarding the process are noted. First, a sample of ideas previously generated by the group was shown on new forms as seed ideas to prompt for further ones. Second, ideas' originators were not identified so as to reduce possible process losses associated with "conformance pressure" and "evaluation apprehension" (Nunamaker et al., 1991). Third, during the process, no explicit coordination was required among group members. At the end of each session, the complete list of ideas generated was broadcast to participants.

Participants in the electronic communication group interacted via EM; no verbal communication was allowed. At any time during the discussion, the parallel communication feature of EM allowed group members to send a message that was broadcast to the whole group. Any previous message received could be revisited at anytime.

Dependent Measures

Availability bias was measured as the difference in total ratings assigned by the groups to the four high-availability items and the four low-availability items. These data were captured in the forms filled by each group to indicate its final agreed upon ratings for each of the eight PAQ items.

Number of ideas generated and number of solutions proposed were derived from the videotapes that captured the interactions between group members and from computer log files that captured all electronic communications, including EBS and EM. A professional transcriber was hired to transcribe the videotapes. These transcriptions and the computer log files were then subjected to content analysis. The second author and a research assistant separately and independently performed the coding. The following coding instructions were given to the coders. *Number of ideas generated* was measured by counting all references made to instances where the item-in-question was either encountered, or not so, in a secretary's job, e.g., a participant mentioning that "attention to detail" was needed when typing business letters. *Number of solutions proposed* was measured by counting the occurrences where a specific rating was suggested, e.g., a participant proposing that "hand operated controls" be assigned a very low score of one, since it had little to do with being a successful secretary.

The interrater reliability for the two coders was 91%, calculated via Scott's pi (Scott, 1955). This is the reliability score for a larger number of categories, including idea generation and solutions proposed.

Procedure

The steps in this experiment were (1) training and (2) experimental task performance. Before working on the experimental task, participant groups received training on the use of the support tools (EBS and/or EM, where applicable) and undertook a practice problem similar to the job evaluation task, with the job target being an insurance underwriter.

For the experimental task, for each of the six PAQ items, groups assigned to the EBS condition spent the first 3 minutes using the EBS tool for idea generation and the next 3 minutes (maximum) deciding on the rating for the item. The lengths of time assigned for idea generation and discussion were determined based on pretest observations. Whereas a shorter time might not be sufficient, longer time led to boredom and silence.

Groups assigned to the no-EBS condition were allowed up to 6 minutes (maximum) to decide on the rating for the item. After finishing one item, the group moved to the next until all eight were completed. The discussion associated with assigning a rating was conducted either electronically or verbally, depending on the communication condition the group was assigned to.

For the communication medium dimension, groups assigned to electronic communication made use of the EM facility for any communication, while those assigned to verbal communication communicated verbally. The three participants in each electronic communication group were colocated in the same room. Each participant had a separate table with a personal computer on it. The tables were arranged so that participants could not see each other's screens, but could see each other. Each participant could broadcast a message to the others at any time during the discussion. The EM facility employed was similar to any popular e-mail facility; therefore, the participants did not experience any difficulties in using the system. The research assistant present made sure that no verbal communication took place.

A concern that could be raised about the experimental design is the fact that the no-EBS groups were given more time to come up with a rating (6 minutes) than the EBS groups (3 minutes), but the latter were first given another 3 minutes to generate ideas. This was done to keep the total time available to each group the same. Any other type of design would have given one of the groups more time and presumably an extra advantage. It is also most likely the case that the no-EBS group would generate ideas during these 6 minutes in addition to coming up with ratings, as the data in Table 3 indicates. By such a design, we are differentiating between the two groups sharply by having one group focus on brainstorming using a specific, structured method for a period of 3 minutes, while keeping the total time the same.

TABLE 2

Means (Standard Deviation and *N*) for "Availability Bias"

	EBS		
	Present	Absent	Total
Communication medium			
EM	4.20	4.80	4.50
	(1.55, 10)	(2.35, 10)	(1.96, 20)
Verbal	4.50	7.70	6.10
	(2.88, 10)	(3.34, 10)	(3.45, 20)
Total	4.35	6.25	5.30
	(2.25, 20)	(3.18, 20)	(2.88, 40)

Note. Rating for an item ranged from 0 to 5 where increasing value corresponds to higher relevance of the item to the job.

ANALYSIS OF EXPERIMENTAL RESULTS

Analysis of variance (ANOVA) was used for statistical analysis.

Number of ideas generated was greater in EBS groups ($M = 151.83$) than in baseline groups ($M = 54.37$) ($F = 78.41$, $p < .01$). Availability bias was lower in EBS groups ($M = 4.35$) than in baseline groups ($M = 6.25$) ($F = 3.58$, $p = .067$). Hypotheses 1 and 2 were both supported. Tables 2 and 3 show the corresponding means.

As a test of the mediating role of number of ideas generated, the method suggested by Baron and Kenny (1986), namely a series of regression equations that model the relationships among the mediator, the independent variable, and the dependent variable, was used. EBS influenced both availability bias and the total number of ideas generated, as discussed before. However, the total number of ideas did not significantly influence availability bias either when it was the sole predictor in the regression equation or when both EBS and total number of ideas were predictors. Therefore, Hypothesis 3, which stated "the number of ideas generated will mediate the effects of an EBS in lowering availability bias," was not supported.

TABLE 3

Means (Standard Deviation and *N*) for "Number of Ideas Generated"

	EBS		
	Present	Absent	Total
Communication medium			
EM	113.80	41.20	65.40
	(33.43, 5)	(24.15, 10)	(44.15, 15)
Verbal	179.00	69.00	117.13
	(29.18, 7)	(27.16, 9)	(62.53, 16)
Total	151.83	54.37	92.10
	(44.70, 12)	(28.68, 19)	(59.63, 31)

However, there was some evidence showing that the number of ideas generated reduced the availability bias when we analyzed the EBS and non-EBS groups separately. For the EBS–EM and EBS–verbal communication treatments, the correlations between number of ideas generated and availability bias are −0.36 and −0.47, respectively, indicating that for EBS groups the higher the number of ideas generated the lower the availability bias. The correlations for the non-EBS groups are 0.42 and 0.15, respectively. Thus, it appears that the ideas generated by the EBS groups are more influential in reducing the availability bias than those of the non-EBS groups.

Number of solutions proposed was greater in EM groups ($M = 71.13$) than in verbal communication groups ($M = 55.13$) ($F = 4.72$, $p < .05$). Availability bias was smaller in EM groups ($M = 4.50$) than in verbal communication groups ($M = 6.10$) ($F = 4.70$, $p < .05$). Hypotheses 4 and 5 were both supported. Table 2 and Table 4 show the corresponding means.

Using Baron and Kenny's (1986) method we conducted a test to determine if the number of solutions generated was a mediator. EM influenced both availability bias and the number of solutions generated, as discussed before. However, the number of solutions generated did not significantly influence availability bias either when it was the sole predictor in the regression equation or when both EM and total number of solutions were used as predictors. Hypothesis 6. which stated "the number of solutions generated will mediate the effects of EM in lowering availability bias," was not supported.

However, there was evidence that electronically communicating groups were more divergent in their consideration of possible solutions; that is, they were less prone to groupthink. The range of the ratings suggested (between the lowest and highest rated items among the eight PAQ items) was significantly higher in EM groups than in verbally communicating groups ($M = 13.5$ vs. 6.8; $F = 33.67$, $p < .01$). Furthermore, a significant negative correlation was found between the range of ratings suggested and availability bias ($r = -0.37$). We therefore hypothesize that the degree of divergent opinions raised, that is, the wider scope rather than the sheer number of solutions, might be a better mediator of EM on availability bias.

To gain a better understanding of why bias reduction took place, especially

TABLE 4

Means (Standard Deviation and *N*) for "Number of Solutions Proposed"

	EBS		
	Present	Absent	Total
Communication medium			
EM	65.67	74.40	71.13
	(14.60, 6)	(20.29, 10)	(18.36, 16)
Verbal	54.57	55.56	55.13
	(22.07, 7)	(17.73, 9)	(19.04, 16)
Total	59.69	65.47	63.13
	(19.12, 13)	(20.95, 19)	(20.18, 32)

in regards to the expectation that availability bias occurs primarily in events of lower, rather than higher, availability, tests were conducted on two components that made up the availability bias measure.

Total ratings for low-availability items were higher with the EBS condition ($M = 12.10$) than with the baseline ($M = 9.95$) ($F = 7.57$, $p < .01$). Similarly, total ratings for low-availability items were higher with EM ($M = 12.20$) than with verbal communication ($M = 9.85$) ($F = 9.04$, $p < .01$) (see Table 5). On the other hand, there were no significant differences under either treatment in total ratings for high-availability items.

DISCUSSION AND CONCLUDING COMMENTS

Both the EBS and the EM facilities were instrumental in reducing the availability bias. In both cases, the reduction in bias was due to the increased focus of the group on the low-availability items. Since availability bias is mainly due to the difficulty one has in imagining or retrieving those instances that do not come to mind easily, it is clear that the use of the computer-based tools guided the group process in the desired direction.

However, EBS and EM influenced outcomes in different ways. EBS increased the total numbers of ideas generated; that is, it expanded the ISS. This is consistent with Easton et al.'s (1990) findings in a different task context. For the EBS (but not the non-EBS) groups, we also observed a significant negative correlation between number of ideas generated and availability bias. The increased ISS due to EBS, presumably by virtue of containing more ideas pertaining to low-availability items than was the case without the EBS tool, led to lower bias.

EM helped to reduce availability bias by enabling the group to suggest and explore a greater range of possible solutions *before* reaching a final agreement. This is consistent with Easton et al.'s (1990) finding that electronic discussion improved performance in intellective tasks. Bias reduction was achieved through a reduction of process losses, such as groupthink, in part by lowering social presence in electronically communicating groups. EM communication

TABLE 5

Means (Standard Deviation and *N*) for "Ratings for Low-Availability Items"

	EBS		
	Present	Absent	Total
Communication medium			
EM	12.90	11.50	12.20
	(1.73, 10)	(2.01, 10)	(1.96, 20)
Verbal	11.30	8.40	9.85
	(2.16, 10)	(3.57, 10)	(3.23, 20)
Total	12.10	9.95	
	(2.08, 20)	(3.24, 20)	

expanded the group's SDS, that is the group engaged in generating more alternative solutions as evidenced by not only the increase in the number of times ratings were proposed, but more importantly the increased range of or divergence in the ratings proposed. Interestingly, EM led to much fewer ideas generated compared to EBS (65 vs. 151; see Table 3) presumably because speaking is faster than typing. Therefore, the contribution made by EM to increasing the scores on the low-availability items is not through expanding the ISS, but by enlarging the range of the SDS.

From a practitioner's perspective, the major concern is in debiasing effectiveness. The cost brought about by having a decision-making or planning team seriously affected by availability bias can range from cosmetic losses, which the team and company may not even be aware of, to disastrously wrong judgments that would unmistakably manifest themselves. This study offers at least two sets of implications one can draw upon. The first attends essentially to the managerial facet. In the process of reaching a group judgment, management should encourage group members to identify and discuss a larger scope of ideas and propose divergent solutions. While this may lead to a larger expenditure of time and effort, it would be compensated by the gains in effectiveness. The second deals with the provision of information technology for decision support; it addresses how debiasing can be supported. The use of EBS and EM, which has been shown in this study to bring about lower availability bias, should be encouraged to support the process of making group judgments. Since these are not sophisticated tools given today's technology, they do not call for significant investments in cost or training. The important consideration is to apply each of these tools at the appropriate phases in a group's interaction to bring about the desired outcomes.

This study has made a contribution to the EBS literature. In particular, the usefulness of EBS in aspects other than increasing the number of ideas generated has not been well understood. The current research has demonstrated that EBS helps to reduce availability bias, thus identifying its role as a debiasing tool. This study also contributes to the literature on judgment biases. The literature is significant in identifying the phenomenon (a systematic bias in human judgment) and formulating the problem (availability heuristic) (e.g., Tversky and Kahneman, 1973). The engineering aspect, i.e., debiasing, has not been greatly researched. From the few studies conducted comparing groups versus individuals (e.g., Stasson et al., 1988), we know that the former is more effective in reducing the availability bias. The contribution of this study is twofold. First, it suggests a mechanism to further reduce this bias by utilizing computer-based support for enhancing group communication. Second, it shows that EBS and EM reduce bias by mainly expanding the group's focus on the low-availability items. Further research is needed to better understand why and how information technology support influences the process and outcomes of group judgments. Although this study has investigated two potential mediating variables between a debiasing tool and level of bias, we observed that it is not necessarily the total number of ideas or solutions generated that act as mediators, but it might be other characteristics such as how these ideas are

generated (via EBS) or what the range of solutions generated is. More research is needed to fully test these exploratory findings about mediators that lead to lower biases in these problem contexts. Another issue to investigate is the optimum group size for lowering the availability bias, as well as understanding the group size range in which EBS- and EM-type support tools are most effective.

In summary, the current study offers an exploratory understanding on how group biases may be reduced. It attempts to provide a starting point for the study of the use of two popular computer-based tools in judgment situations. The findings that these tools are effective at reducing judgment biases should be of significance both to the continuing efforts at developing a stronger theoretical basis for studying the impact of IT as well as to the better design of group debiasing tools.

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