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An Experimental Study of the Attention-based View of Idea Integration: The Need for a Multi-level Dependent Variable

Elahe Javadi
Illinois State University
ejavadi@ilstu.edu

Judith Gebauer
University of North Carolina Wilmington
gebauerj@uncw.edu

Abstract:

Decision making involves creating a rationale for supporting a choice. Groups make many decisions that require individual members to interact and collaborate with one another. High-quality decisions require that group members pay attention to different perspectives on the decision topic, process diverse or even opposing ideas, and combine (i.e., integrate) those ideas into coherent arguments. Despite the availability of information systems (IS), such as electronic brainstorming systems (EBS), to support group decision making, researchers have relatively understudied their role in idea integration. In this paper, we focus on the role of IS user interface design in idea integration. Applying an attention-based view of idea integration, we present a model and subsequent experimental study to explore the interaction between idea visibility, prioritization, and idea integration and the moderating effects of information diversity and group size. While our results generally support the attention-based view, they also identify the need to refine the dependent variable and distinguish between different types of idea integration. The findings have implications for electronically enabled brainstorming and group decision making.

Keywords: Idea integration, Prioritization, Visibility, User interface, Brainstorming.

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1 Introduction

Many organizations use decision support systems (DSS) to facilitate various stages of the decision-making process, such as gathering, processing, and integrating information. Group decision support systems (GDSS) can facilitate decision-making among groups of individuals (DeSanctis & Gallupe, 1987). Existing studies on DSS and electronic brainstorming have examined quantity, quality, and quality gaps of the ideas generated during the decision-making or ideation process (e.g., Reinig, Briggs, & Nunamaker, 2007; Valacich, Jung, & Looney, 2006). Pooling ideas and information from different people and sources and integrating those ideas constitute other critical decision-making components. Idea integration involves attending to diverse perspectives and ideas, processing those ideas at the individual level, and creating a coherently integrative rationale for supporting a decision choice (Homan, Van Knippenberg, Van Kleef, & De Dreu, 2007). Although individual cognitive capabilities impact groups' and organizations' innovative capacities, effective integration of ideas can help individuals realize and enhance those capabilities (Valacich et al., 2006). Assuming that no one individual has sufficient information to formulate all different perspectives, idea integration becomes critical to identifying and incorporating the knowledge available on a decision topic because it can help individuals clarify and reduce the pool of available ideas (Bragge et al., 2011; Dennis, 1996; De Vreede, Briggs, van Duin, & Enserink, 2000; Robert, Dennis, & Ahuja, 2008).

In this study, we focus on idea integration. Because idea integration requires both perceptive and cognitive efforts, individuals often find it easier to act autonomously than to elaborate on others' ideas (Madsen, Woolley, & Sarangee, 2012). Therefore, we can view effective information system (IS) support for idea integration as an important enabler of collaborative decision making. However, researchers have identified integrating ideas or other creative artifacts and evolving them as top research and practical challenges in designing innovative participation architectures (Majchrzak & Malhotra, 2013). Thus, we need tools that can help to analyze various idea dimensions and create conceptual connections among them (Gruenfeld & Hollingshead, 1993; Okhuysen & Eisenhardt, 2002).

Contribution:

This paper contributes to the research on group decision making and on group-decision support systems (GDSS) and, in particular, on designing GDSS user interfaces. The paper focuses on idea integration—an important aspect of group decision making that happens when group members build on others' ideas and combine them with their own. Building on the attention-based view of idea integration (Javadi, Gebauer, & Mahoney, 2013; Santanen, Briggs, & De Vreede, 2004), we present the results of an empirical study that largely confirm the theory and, in particular, the need for individuals to pay attention to others' ideas as a condition for idea integration but also call for a more refined approach to the dependent variable idea integration. The empirical results provide guidelines for designing GDSS user interfaces as they identify idea visibility and prioritization as antecedents of idea-integration. The empirical results also reveal a need to refine the dependent variable of idea integration as a multi-level construct, which we operationalize with two levels—communicative and elaborative idea integration. We found strikingly complementary for both levels: communicative idea integration was associated positively with idea visibility (a user interface design aspect) and user-perceived value of information. In contrast, elaborative idea integration exhibited no significant direct association with visibility but had significant moderated association with visibility × diversity, and that elaborative idea integration has a positive association with user-perceived value of idea integration. For communicative idea integration, we found that perceived value of information moderated a positive association with prioritization of ideas (another user interface design aspect), whereas, for elaborative idea integration, perceived value of idea integration mediated that same association. In summary, the paper provides guidelines to GDSS designers and group facilitators to carefully identify the form of idea integration that best fits the task at hand before designing IS platforms and interfaces to support and enable the integration.

While researchers in research areas such as electronic brainstorming and GDSS have previously discussed idea integration, we still lack specific guidelines for designing interfaces. Studies that examine electronic brainstorming have conceptualized idea integration as the explicitly referencing ideas in the form of comments and usually categorized it as a communication-effectiveness measure (Fjermestad & Hiltz, 1999, 2001; Pinsonneault, Barki, Gallupe, & Hoppen, 1999). In addition, researchers have labeled referencing previously generated ideas that pertain to a task *elaboration* and included elaboration in a collection of productivity measures (De Vreede et al., 2000; De Vreede, Briggs, & Reiter-Palmon, 2010). Some research studies have identified knowledge integration as resulting from elaboration and described it with information exchange and information processing at the individual level and integration at the group level (Homan et al., 2007). Information adoption and use, two closely related constructs that IS research studies use, involve attending and appropriating relevant shared information when performing a task (Dennis, 1996; Ferran & Watts, 2008; Sussman & Siegal, 2003). The attention-based view of idea integration defines the concept as the explicit reference to and use of the evidence that is based in the ideas of a partner and provides a conceptual research framework for its antecedents (Javadi et al., 2013).

Studies that have empirically examined and practically applied constructs that relate to idea integration also indicate that integration does not occur automatically (Homan et al. 2007). Individuals must be able and motivated to integrate ideas (Santanen et al., 2004). Consequently, decision support tools' user interface plays a critical role in facilitating idea integration and, thus, in enhancing decision making and group-brainstorming productivity. In one application, Chen et al. (2007) included a search function in their TeamSpirit tool that let facilitators consolidate similar ideas. Consolidation helped the facilitators efficiently distribute a team member's attention among dissimilar ideas. Another suggested tool (IdeaHound) applied semantic modeling to help people generate ideas (Siangliulue, Chan, Huber, Dow, & Gajos, 2016), while several applied studies include suggestions for designing incentive mechanisms to encourage people to elaborate on already proposed ideas rather than autonomously create new ones (Majchrzak & Malhotra, 2013). The importance of idea integration also became evident during an experiment with IBM's collaboration platform InnovationJam that showed limitations in how most people recognize and build on others' ideas online (Bjelland & Wood, 2008). To offset the shortcomings and to identify common themes and dimensions, a group of experts had to review and group the thousands of ideas shared on the platform.

In this paper, building on the previous theoretical constructs and practical examples, we further explore the attention-based view of idea integration and its suggested antecedents with an experimental study given that researchers have not yet empirically reviewed that theory. Epistemologically, we primarily focus on theory testing and on addressing the following research question (RQ):

> **RQ1**: What are the associations between user interface features and idea integration in the context of group decision making and, in particular, electronic brainstorming systems (EBS)?

We use the attention-based view of idea integration (Javadi et al., 2013), which builds on the cognitive network model (CNM) of creativity (Santanen et al., 2004), as the study's main theoretical underpinning. Given the inherent complexity in the behavioral construct idea integration, we also explore the dependent variable and address the following research question:

> **RQ2**: How should one operationalize idea integration?

The paper proceeds as follows: in Section 2, we provide some theoretical context. In Section 3, we describe the research model and hypotheses. In Section 4, we report the results of the structural model analysis. In Section 5, we discuss the findings. Finally, in Section 6, we conclude the paper.

2 Theoretical Background

Building on the cognitive network model (CNM) of creativity (Santanen et al., 2004) and ability and motivation framework (Thoemmes & Conway, 2007), the attention-based view of idea integration assumes that one needs to attend to others' ideas for idea integration and that one can actively manage attention through an IS user interface (e.g., as part of an electronic brainstorming system) (Javadi et al., 2013; March & Simon, 1958; Ocasio, 1997; Simon, 1947). Specifically, prior literature on brainstorming has used *visibility* and *prioritization* as two interface-based mechanisms (interventions) to direct and reinforce attention to ideas (Okhuysen & Eisenhardt, 2002; Sweller, 1994; De Vreede et al., 2000).

Table 1 illustrates various understandings that relate to idea integration. Different research studies do not uniformly apply the concept; as such, it exhibits diversity in the cognitive effort that underlies the integration act. The selected list includes simple applications, such as merely referencing others' ideas (Robert et al., 2008), but also more complex concepts, such as advancing and refining others' ideas (Bjelland & Wood, 2008). Javadi et al. (2013) acknowledge the concept's inherent complexity, but they do not explicitly reflect such complexity in the theory propositions. Since we test the attention-based view of idea integration (Javadi et al., 2013), we can see that we need to refine the dependent variable.

Table 1. Studies on Idea and Knowledge Integration

Study	Dependent variable	Conceptualization/ operationalization	Research context
Baker-Brown et al. (1992)	Integrative complexity	Recognizing different dimensions of a topic and creating connections among them	Integration of dimensions of a given topic in written communications
Dennis (1996)	Information use	Using unique information that others own	Information recall; exchange-processing and use theory
Okhuysen & Eisenhardt (2002)	Knowledge integration	Using unique knowledge pieces owned by others	Use of formal interventions for directing and switching attention
Sussman & Siegal (2003)	Information adoption	Internalizing knowledge in an organizational advice-receiving context	Adoption and information influence theories
Homan et al. (2007)	Information elaboration	Elaborating on task-relevant information and perspectives	Pro-diversity as integration enabler
Chen et al. (2007)	Idea consolidation	Merging ideas that contain similar or duplicated concepts	Search tools for facilitators
Thoemmes & Conway (2007)	Integrative complexity	Perceiving differences among political viewpoints and articulating connections	Integration of political viewpoints in presidential state of the union addresses
Robert et al. (2008)	Knowledge integration	Referencing others' ideas	Social capital theory
Bjelland & Wood (2008)	Augmentation	Advancing and refining others' ideas	Large-scale online collaboration platform (InnovationJam)
Majchrzak & Malhotra (2013)	Idea evolution	Collaboration through feedback-based idea evolution	Design of innovation participation architecture for crowdsourcing platforms
Javadi et al. (2013)	Idea integration	Explicitly referencing and using evidence based in a partner's ideas	Design of EBS
Siangliulue et al. (2016)	Semantic modeling	Semantic relationships among ideas	Integrating semantic modeling into the primary task of idea generation (IdeaHound)

To date, most IS research studies have operationalized idea integration and similar concepts as a single construct. In contrast, the research literature in psychology and studies that focus on integrative complexity in particular hint at different dimensions in idea integration's underpinnings (e.g., Baker-Brown et al. 1992). In the current study, we first draw on the extant IS literature to define idea integration as a single construct (Dennis et al. 1996). We then combine IS and cognitive psychology research findings to explain why we need to differentiate among different types of integration in order to tease out the role of information technology features to advance the desired type(s) of idea integration in a given context.

3 Research Model

In this section, we test Javadi et al.'s (2013) attention-based view of idea integration empirically but suggest three modifications: 1) acknowledging idea integration's complexity (Baker-brown et al., 1992), we distinguish between two different idea-integration levels: simple references (communicative idea integration) and further elaboration (elaborative idea integration); 2) acknowledging the difficulty in measuring cognitive processes empirically, we incorporate the two concepts knowledge activation and cognitive load into our hypotheses; 3) we split the construct perceived integration efficacy into perceived value of information and perceived value of idea integration.

The attention-based view of idea integration defines an idea as "a basic element of thought that is represented by verb-object combinations and consists of at least one testable proposition" (Javadi et al., 2013, p. 4). As such, idea definition excludes normative statements without justification that express simple preferences ("I prefer A over B"), simple descriptive statements ("we are currently at location C"), and statements that lack relevance to the problem at hand. Similarly, and again in line with the attention-based view of idea integration and related studies (Table 1), we define idea integration as explicitly referencing and using one or more testable propositions (i.e., idea dimensions) that exist in others' ideas (Javadi et al. 2013). Based on these definitions, we present our hypotheses in Sections 3.1 and 3.2.

3.1 Hypotheses: Idea Visibility

The attention-based view of idea integration uses visibility and prioritization as two interface-based interventions to channel individuals' attention (Javadi et al., 2013; Okhuysen & Eisenhardt, 2002; De Vreede et al., 2000). Because individuals can typically focus on only a limited number of ideas at a time (Miller, 1956; Simon, 1947; Sweller, 1994), the theory suggests that they can attend to only a portion of a larger idea pool. Therefore, the ideas generated and shared during brainstorming compete with each other to receive brainstormers' attention (Hansen & Haas, 2001). Methods that GDSS designers commonly use to organize an idea pool on the screen to direct brainstormers' attention include both chronological order and rank-based order.

In the attention-based view of idea-integration, ideas' visibility corresponds with the construct *stimuli quantity per time unit* in the cognitive network model of creativity (CNM), which posits that the construct stimulates individuals to search for and retrieve relevant concepts and that, thus, enables them to create connections among those related concepts (Atkinson & Shiffrin, 1968; Santanen et al., 2004). Along with Briggs (2006), we maintain that the construct visibility does not depend on any particular type of GDSS and define visibility as the portion of the idea pool that one can see on a computer screen at any given time without expending additional effort (e.g., clicking). We hypothesize that visible ideas can direct individuals' attention and, in turn, impact the extent to which they activate relevant concepts in their working memory. Therefore:

Hypothesis 1: Idea visibility is positively associated with idea integration.

Confirming the expectation that exposure to high levels of stimuli may cause cognitive overload in individuals (Miller, 1956; Santanen et al., 2004; Sweller, 1994), experimental research studies have found that attending to input from others can hinder individuals' productivity in brainstorming (Potter & Balthazard, 2004). Thus, exposure to others' ideas can either benefit or hinder idea integration depending on the extent (Potter & Balthazard, 2004).

As attended-to ideas become more diverse, the potential for integration increases because information diversity by itself can stimulate integration (Javadi et al., 2013; Van Knippenberg, De Dreu, & Homan, 2004). Indeed, researchers have linked diversity in the information in the ideas that individuals in a group generate and share to higher levels of creativity and cognitive complexity (Harrison & Klein, 2007). Information diversity and its associated diversity in stimuli can draw higher levels of disparity among the concepts that individuals retrieve from their long-term memory (Santanen et al., 2004). The greater the disparity among activated concepts in an individual's working memory, the greater the potential for knowledge integration. If individuals possess and share homogenous or even identical knowledge, integration offers little gain (Grant, 1996a). Given that integration occurs only when individuals combine different perspectives, highly diverse visible ideas will more likely stimulate individuals to generate integrative ideas compared to a less diverse visible ideas ceteris paribus (Javadi et al., 2013). Therefore, we hypothesize that diversity moderates the relationship between visibility and knowledge activation:

H2: Information diversity moderates the relationship between idea visibility and idea integration, such that the association of idea visibility and idea integration is stronger for higher levels of information diversity.

Based on the CNM, the attention-based view of idea integration further posits that automatic (unconscious) and conscious components coexist (Javadi et al., 2013; Santanen et al., 2004). The automatic part occurs without intention, but the rest requires intention and conscious processing. While visibility has bearings on exposure as an instrument for directing the unconscious part of activation, prioritization appertains to the conscious aspect of spreading activation, which we discuss in Section 3.2.

3.2 Hypotheses: Prioritization

Prioritization refers to ordering ideas on a screen based on some criterion. In GDSS, few feasible real-time methods to prioritize ideas exist, such as prioritization based on a group's collective evaluation and and prioritization based on a facilitator's evaluation. Accurately evaluating ideas based on organizational goals during brainstorming involves inherent difficulties (Litchfield, 2008). Therefore, GDSS can base prioritization on aggregating individual preferences about shared ideas via a rating scale that indicates them. Several recent online GDSS discussion platforms (e.g., TeamSpirit by Chen et al., 2007) apply similar mechanisms, such as the starred rating systems that Amazon.com reviews or Yahoo! Answers use.

To capture how an individual evaluates others' ideas and the individual's proclivity to generate ideas, Javadi et al. (2013) suggested the construct *perceived integration efficacy* that encompasses two components: the way in which 1) brainstormers evaluates others' ideas (perceived value of information) and 2) perceives gains from idea integration (perceived value of integration). Javadi et al. (2013) further posited that an individual's perceived integration efficacy may be associated positively with prioritization: to the extent that brainstormers prioritize ideas based on the group's collective evaluation, they may attribute more value to the displayed ideas. Therefore, prioritization can help reduce uncertainty in an individual's decision attitude towards idea integration. In the current study, we assess the two components of perceived integration efficacy separately. Thus, we hypothesize:

H3: Prioritization is positively associated with perceived value of information.

H4: Prioritization is positively associated with perceived value of idea integration.

Perceived value of information is similar to *information usefulness* (Sussman & Siegal, 2003) but more general than *perceived information credibility* (Dennis, 1996), a construct that previous studies on information adoption and use have used. Perceived value of idea integration conceptualizes an individual's belief regarding the extent to which integration contributes to the value of the ideas that the individual generates (Javadi et al., 2013).

Higher levels of idea integration's perceived value should elicit more idea integration because the actions individuals take generally depend on their beliefs about what consequences those actions will have (Simon 1947). Researchers have also suggested information's perceived value to augment idea use. For instance, the extant literature on information adoption and use posits that perceived usefulness, credibility, and/or value of a knowledge item will trigger its use and adoption (Sussman & Siegal, 2003). Therefore, we hypothesize:

H5: Perceived value of information is positively associated with idea integration.

H6: Perceived value of idea integration is positively associated with idea integration.

However, we lack the scope here to discuss how accurately a particular prioritization method reflects an idea's true value or whether individuals who select ideas for integration moderately or significantly discount prioritization criteria. According to the attention-based view of idea integration, the presence of a prioritization mechanism is associated positively with how much attention individuals allocate to the shared ideas and with the extent to which they review and consider such ideas (Javadi et al., 2013).

Lastly, group size has been an important moderator in theoretical and empirical research studies that have examined GDSS and electronic brainstorming (Dennis & Valacich, 1999; Dennis & Wixom, 2001; Valacich, Wheeler, Mennecke, & Wachter, 1995). Likewise, the attention-based view of idea integration posits that group size moderates the association between prioritization and perceived integration efficacy (Javadi et al., 2013). Researchers believe prioritization, as a mechanism to signal ideas' value (Sussman & Siegal, 2003), to be more credible in larger groups than in smaller groups because larger groups include more people that can evaluate ideas (Gallupe et al., 1992). According to the elaboration likelihood model, individuals tend to process ideas' information content and use peripheral cues such as ratings to assess their value (Petty & Cacioppo, 1986). Consequently, we expect the extent to which prioritization affects the perceived value of information to be linked with group size. Moreover, since an idea pool's size tends to increase with group size, prioritization should have a more intense effect on idea filtering in larger groups (with a wider range of positions on the list of ideas) than in smaller groups. Therefore, use group size as a moderator in our model as follows and hypothesize:

H7: Group size moderates the relationship between prioritization and perceived value of information such that the positive association between prioritization and perceived value of information is stronger for larger groups.

H8: Group size moderates the relationship between prioritization and perceived value of idea integration such that the association between prioritization and perceived value of idea integration is stronger for larger groups.

Figure 1 summarizes our research model and hypotheses derived from the attention-based view of idea integration. We describe our experimental study in Section 3.3.

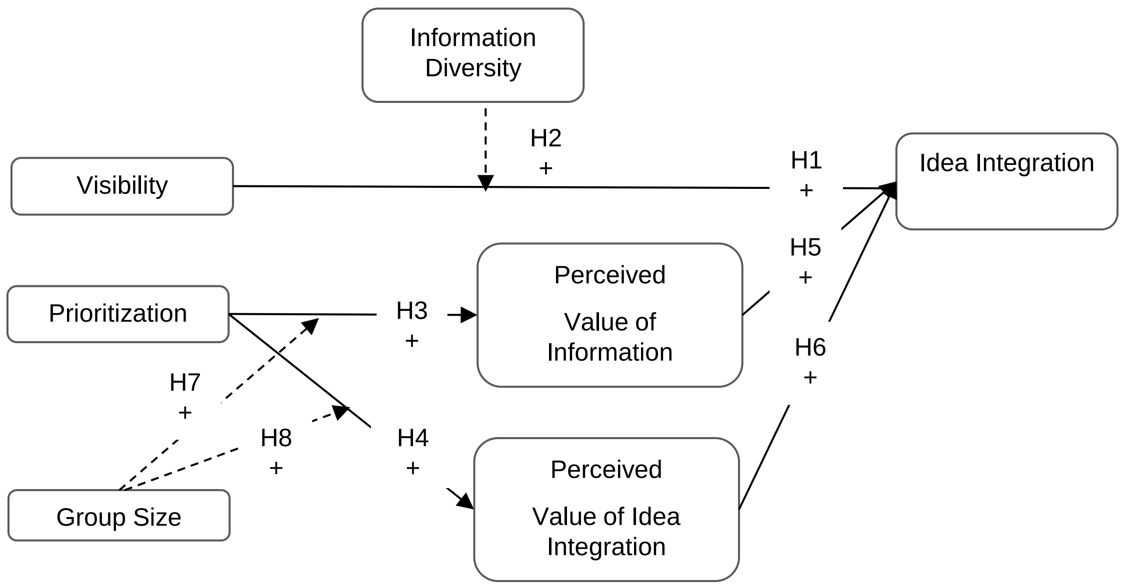

Figure 1. Research Model

Similar to earlier studies that have examined individuals' behavior in DSS and EBS (Chen et al., 2007; Dennis, Valacich, Connolly, & Wynne, 1996; Santanen et al., 2004), we tested the hypotheses we outline above in laboratory experiments using an open idea-generation task. In our study, we asked participants to generate ideas on what items would improve their chances to survive in a desert environment[1] (Dyer, 1987; Johnson & Johnson, 1982; Homan et al., 2007). The experiment had a two by two by two factorial design (visibility: low, high; prioritization: yes, no; group size: small, large), and we randomly assigned participants to the experimental conditions. Participants communicated electronically in groups via an experimental software system with which we could manipulate visibility and prioritization. We provide more details about the experiment setup in Sections 3.3 to 3.6.

3.3 Experimental Software System

The software system displayed shared ideas on the upper part of the screen, while users typed new ideas into the lower section. Users could post their own ideas using a "share" key (Dennis, 1996). Additionally, they could rate others' ideas, refer to them, or comment on them. The software, which the website ideation-experiment.org hosted, stored the ideas that participants exchanged during each experimental session and produced transcripts that we later used to assess idea integration. The experimental transcripts included an activity report of every participant and aggregate information such as the total number of posts, comments, and the number of posts that each individual rated.

To motivate active participation during the experiment, we provided each participant with a score that increased for activities that contributed to the group discussion, such as posting an idea and rating or commenting on other participants' ideas. An individual's score influenced their chance to win a lottery. We intended the scoring mechanism that rewarded individuals for commenting on and referring to each

[1] The Desert Survival Situation is published by and copyrighted by Human Synergistics, Plymouth Michigan. We used the exercise in the dissertation that served this paper's basis with permission from Human Synergistics.

other's ideas to promote idea integration during the experimental sessions. We kept the scoring system constant across different conditions in order to avoid interference with the primary research variables.

3.4 Participants

We recruited participants in the study from two upper-level business courses at a large Midwestern university in the United States, and they participated in exchange for extra credit and inclusion in a lottery. We recruited participants in the pilot studies from the general population at the same university and paid them for their participation in the experiment. In both studies, we randomly assigned participants to different experimental conditions, and we presented all participants in a particular session with the same conditions.

3.5 Task and Procedures

An open-ended idea generation task represents a suitable choice to examine idea integration because the solution space is broad and contains many opportunities for integration, which can result in a large variety of results (Dennis, 1996; Homan et al., 2007). We described a scenario based the Desert Survival Situation, which Human Synergistics publishes, as the chosen task that participants performed[2]. The task involved a survival problem in a desert. We asked participants to discuss and generate as many ideas as possible on what items would increase their chances to survive. An idea could include a new item, a new use for an item that someone proposed earlier, or follow-ups and counter-arguments on previous ideas. Instructions stated that the suggested items should be portable. Additionally, we asked participants to explain why they needed the selected items to survive the described situation (reference to desert survival task).

Each session lasted approximately 30 minutes and included an introduction (10 minutes), experiment (15 minutes), and debriefing (five minutes). The experimenter began each session by reading a set of statements that also included answers to three frequently asked questions to the participants. The participants then read four pages of online instructions and had the opportunity to ask clarification questions. During the main part of the experiment, the participants used the system's discussion forum to generate and exchange ideas and discuss the survival situation. The session ended with a short discussion and debriefing on our research goals.

3.6 Treatments

We treated all three variables in our experiment design (visibility: low, high; prioritization: yes, no; group size: small, large) as binary during the analysis (Table 3). Visibility varied based on the number of posts that the screen displayed at any given time. Additionally, participants could navigate through different pages. Prioritization meant that the posts appeared based on users' collective evaluation; no prioritization meant that posts appeared based on reverse chronological order. Small groups included two to three participants and large groups included four to six participants.

To validate the effectiveness of the distinct visibility levels, we conducted pilot tests in which, in a post-experiment questionnaire, we asked the participants: "What do you think about the numbers of posts displayed on the screen?". We used a seven-point Likert scale to capture their responses (1: too few; 7: too many).

The mean of the responses by group, as displayed in ANOVA, showed a distinction between the two visibility levels ($p < 0.05$). We considered five or 12 posts on the screen at any given time as low visibility and twenty posts as high visibility. In the post-experimental questionnaire item, we also asked participants: "How did you perceive the order in which posts were posted on the screen?". Again, we captured their responses on a seven-point Likert scale (1: were not prioritized based on their value; 7: were prioritized based on their value).

An ANOVA test of the manipulation check responses aggregated at the group level indicated a significant difference between the two groups: with and without prioritization ($p < 0.05$). After the pilot tests, 226 students participated in 65 experimental sessions. Table 2 shows the number of groups in each experimental condition.

[2] One can find further information on the task on creator's website: http://www.desertsurvival.com/

Table 2. Number of Groups in Each Experimental Condition

	Group size	Group size
	Small/large	Small/large
Low visibility	(4)/(10)	(17)/(12)
High visibility	(4)/(6)	(6)/(6)
	No prioritization	**Prioritization**

3.7 Idea Integration: A Multi-level Construct

Two external coders who did not know about the experimental conditions examined the transcripts and coded all posts in the experimental sessions. We asked the coders to first read an entire transcript to understand the flow of discussions in the groups. The coders then read each statement that individual participants exchanged and coded it as idea *generation* or *integration*. They counted all posts containing an idea, which we define as a statement that includes at least one testable proposition (Javadi et al., 2013), toward the total number of ideas. We define idea dimensions—the building blocks of idea integration—as unique testable propositions, and we define idea integration as explicitly referencing and using one or more testable propositions. Table 3 provides representative examples of ideas and idea integration from the experimental sessions.

Table 3. Ideas (✓) and Idea Integration (✓✓): Examples from the Experimental Sessions

Ideas	**Examples**
One-dimensional idea	*✓ I think some sort of tarp would be useful for shade and shelter.* *✓ First-aid kit to ensure some security against any injury that may occur. Usually contain an abundance of supplies that can be used for several occurrences*
Multi-dimensional idea	*✓ Some sort of outer shell jacket that is waterproof, can be used to collect water if it rains, covers body at night* *✓ We also need to worry about poisonous snakes. Maybe we should bring a snake book so we can identify which ones are poisonous and which ones we can eat.*
Creative idea	*✓ How about a rope? We can take a part of the plane and tie it. Take turns pulling each other. Some of us will sit down and rest.*
Infeasible idea (**not** counted as an idea)	*Maybe we can have some workers get shipped in, too, and they can do the physical labor.*
Idea integration	**Examples**
Acknowledgement	*✓✓I agree; I think shoes would be better since it is quite a long journey and desert temperatures in the night [are] quite cold.* *✓✓I can understand the point of bringing wood and dry leaves.*
Counter argument	*I think that in order to survive, a knife will definitely be needed to hunt for food.* *✓✓The land is barren. I do not believe there are any animals.* *If we can reach signals, then how about cell phone? We can call for help.* *✓✓No, cell phone signals come from towers. There wouldn't be any towers nearby, I don't think.*
Improvement	*How about a torch to help us during the night as it's gonna be pitch dark in the desert?* *✓✓Would a flashlight be better? Although the battery may run out, we wouldn't need anything to light it.*
One additional reason	*Water; a human body cannot go a long time without water.* *✓✓That is a good idea; we will have to carry as much water*
Counter argument and alternative idea	*Since it gets very cold at night, we may need blankets.* *✓✓Blankets would just create more bulk; jackets have more practical usage*
More than one additional reason	*Do you think that energy bars are better or something like dried fruit?* *✓✓Yeah, energy bars are also a good idea. They also are more convenient to carry and can be distributed amongst us in an equal proportion.*

Note that the perceptive and cognitive processes that precede an articulated integrative idea tend to be difficult to observe in practice. Thus, in our study, we assessed idea integration by evaluating the integrative outcome (i.e., the combined idea) and not the processes that lead to it. This approach deviates from the conceptual model in the attention-based view of idea integration (Javadi et al., 2013), which includes mental processes in the form of knowledge activation and cognitive load as antecedents of idea integration However, Baker-Brown et al. (1992) introduced the approach we take in this study to measure integrative complexity, and Thoemmes and Conway (2007) used it to compare the integrative complexity of 41 U.S. presidents' State of the Union addresses.

At this point in our study, we realized that the single-level, one-dimensional construct for idea integration that most previous research studies have used (e.g., see Table 1) and that we set out with did not adequately capture its complexity. When reviewing the interactions between the participants, we noted sizeable differences in the cognitive requirements and motivational factors associated with the effort to integrate ideas, which also manifested in our empirical results from analyzing the data. More specifically, communicative statements that merely acknowledge others' ideas, such as "I agree" (De Vreede et al., 2000), turned out to play a different role in our data set than more extensive elaborations that require higher levels of attentional involvement and cognitive efforts, such as "a first aid kit is a good idea, but I don't think anybody was hurt". Rather than presenting the same analysis twice with and without accounting for variations in complexity of the dependent variable, we distinguish between the two levels of communicative idea integration and elaborative idea integration during the ensuing discussion (see Table 4).

Regarding its face validity, the distinction between different levels of idea integration corresponds with integrative complexity, a well-studied concept in social psychology (Baker-Brown et al., 1992; Suedfeld, Tetlock, & Streufert, 1992). Integrative complexity refers to an individual's tendency to consider relevant information from more than one dimension and includes two phases: () differentiation: perceiving a subject's different aspects and 2) integration: recognizing connections among those aspects (Suedfeld et al., 1992). The "state of integrative complexity" is not necessarily a fixed trait but may change in response to environmental mediators and interventions (Suedfeld et al., 1992).

Once the need for a more refined perspective of idea integration became clear, we established and reviewed a set of coding rules, instructions and coded manuscript examples. Moreover, the coding rationale for the two constructs of communicative and elaborative idea integration that we applied in the current study, while more precise and specific (through using "testable" propositions as building blocks for ideas), resembles the approach that previous research studies on GDSS have used to code discussion posts (e.g., De Vreede et al., 2000, 2010).

While the measurement method that we eventually applied to the experimental transcripts encompasses the initial examples of ideas, idea dimensions, and idea integration that we present in Table 2, we refined it as follows. The basic level of idea integration, which we call communicative idea integration, refers to situations where participants merely acknowledged others' contributions in agreement ("I agree") or disagreement ("I disagree"). De Vreede et al. (2000, 2010) have proposed communicative idea integration to have value with respect to not only recognizing the ideas of others and for giving meaning and value to the referred-to idea but also providing limited reasoning or feedback on the actual content in the shared ideas. As such, it requires only limited cognitive reflection on the information in others' ideas.

In contrast, elaborative idea integration reflects a higher level of integration, which we represent in two ways in this study: 1) Individuals make an explicit effort to better understand the problem at hand by elaborating on the reasons why they criticized or recognized an idea (elaborative idea integration type one) and 2) individuals suggest alternative options to or ways to improve other people's ideas (elaborative idea integration type two). We propose that elaborative idea integration generally requires higher levels of attention and more cognitive involvement and effort than communicative idea integration. To the extent that the resulting forms of idea integration contribute to the decision-making process in different ways, they may also differ with respect to user interface requirements.

To assess the different variations of idea integration, we asked the external coders to complete a row in the coding table with the following information for each statement on the experimental transcripts:

- Number of unique new items
- Is the item justified? (Are reasons included?)
- Communicative idea integration:
    - Challenging or querying someone else's idea without providing any reason

    - Approving somebody else’s idea without providing any additional reason/justification for the item
- Elaborative idea integration (type one)
    - Challenging or querying someone else’s idea with reason but without providing alternatives
    - Approving somebody else’s idea and providing additional reason/justification for the existing item
- Elaborative idea integration (type two)
    - Providing an alternative to/improving an existing idea
- Other: if none of the above applies

Table 4 provides representative examples of the above categories.

Table 4. Coding Different Levels of Idea Integration

Description/definition	Example from experimental sessions
Communicative idea integration	
Challenge without reason: challenging or querying someone else’s idea without providing any reason.	P1: Take a cooler. P2: Why?
Approve without additional reason: approving somebody else’s idea without providing any additional reason/justification.	P1: Maybe some kind of solar-powered flashlight to use with the compass for nighttime travel. P2: I think the flashlight idea is good.
Elaborative idea integration	
Type one	
Challenge with reason: challenging or querying someone else’s idea with reason but without providing alternatives.	P1: Medical first aid kit from plan P2: But they said we weren’t hurt
Approve with reason: approving somebody else’s idea and providing additional reason/justification.	P1: I think in the middle of nowhere map might be better. P2: Yes, especially if we are in a zone with no reception.
Type two	
Alternative: providing an alternative to or improving an existing idea.	P1: How about a flashlight for when it gets dark? P2: Maybe some kind of solar-powered flashlight to use with the compass for nighttime travel.

3.8 Perceived Integration Efficacy

We assessed perceived integration efficacy by separately measuring its two subconstructs: perceived value of information and perceived value of idea integration. After reviewing questions on information sharing and use in the EBS literature (e.g., Dennis 1996), we identified and formulated two sets of four questions to measure perceived value of ideas and perceived value of idea integration. We measured the questions on a seven-point Likert-scale and administered them as part of a post-experiment questionnaire.

We measured perceived value of information (Dennis, 1996) based on the following four questions:

1) I am not sure that all the ideas that others contributed had much value.
2) Some people did not post valuable ideas.
3) I am not sure I completely attributed value to every idea that was posted by others.
4) I am convinced that all the ideas everyone posted were valuable.

We measured perceived value of idea integration, a new construct that we introduce in this study, based on the following four items:

1) Combining my ideas with ideas posted by others created better ideas.
2) I am not sure if using ideas posted by others has helped me generate better ideas.
3) I am convinced if I use ideas posted by other people, I can create better ideas.
4) Using other peoples’ ideas has not helped me create better ideas.

To ensure the measurement instrument for perceived value of idea integration displayed face validity, we invited a group of IS, marketing, and strategic management researchers to review an initial set of questions and to rate them based on their relevance to measuring the construct. From the resulting six questions, we selected the above four items and revised the wording to reflect the researchers' comments. We omitted the following questions: "I feel confident that using other peoples' ideas will help me create better ideas" and "I am certain that if I use ideas posted by other people, I can create better ideas".

We performed a reliability analysis on the measurement items for perceived value of information and perceived value of knowledge integration for 11 pilot groups, which resulted in acceptable Cronbach's alpha values of 0.761 and 0.68, respectively (DeVellis, 2012).

3.9 Information Diversity and Group Size

Information diversity in this paper represents the variety of the ideas (or, more precisely, the difference in information that the ideas contain) that individuals in a group generate and share. Diversity in ideas can lead to more diverse cues, which, in turn, can facilitate knowledge activation and help individuals retrieve additional information from memory. In prior empirical studies on EBS, researchers have manipulated information diversity by using hidden-profile tasks in which they have unevenly distributed information among participants (Mennecke, 1997). One can also measure diversity by the number of unique ideas that a group generates.

To operationalize the diversity of the cues that we presented to individuals, we used the latent semantic analysis (LSA) method (Landauer, Foltz, & Laham, 1998). LSA allows one to measure the similarity between statements based on meaning whereby lower LSA numbers represent high diversity and vice versa. LSA infers meaning based on word usage in a specific context. Thus, if LSA examines several distinct topics with many contributions that bear striking similarities, it will still give a high indication of diversity if the distinct topics markedly differ from one another. This approach concurs with our focus in this paper because presenting the same idea with variant wording can stimulate individuals to search in new and diverse directions in their associative memory. For instance, if one individual suggests food and another individual suggests snack bars (= one unique idea), these ideas represent higher diversity than when both individuals mention the word food only. Researchers have demonstrated LSA to effectively measure the coherence among topics and found its measures to match human coders' measures (Landauer et al., 1998). Here, we used LSA as a proxy measure for information diversity and maintain that LSA represents a better measure than the number of unique ideas.

For each experimental session, we computed the LSA measure between any two posts using the system available at http://lsa.colorado.edu/. We then converted the LSA values, which represent similarity, to represent diversity. We used the average of all $\frac{n(n-1)}{2}$ binary LSA values in an experimental session as the information diversity measure for that session.

4 Structural Equation Model

We analyzed the data we collected from the experimental sessions using structural equation modeling (SEM). SEM constituted a good choice to test our research model because it allows one to simultaneously assess structural and measurement models and to assess multi-step paths (Gefen, Straub, & Boudreau, 2000). We developed and examined the SEM model with Warp3 PLS software that applies the partial least squares (PLS) technique (http://www.scriptwarp.com/warppls).

In order to more precisely understand the complex concept idea integration (as we outline above), we created and analyzed an SEM model with separate variables to measure communicative and elaborative idea integration (type one and two combined) (compare Figures 1 and 2). In Figure 2, we label the hypotheses with C for communicative idea integration and E for elaborative idea integration. We use these labels when discussing the results as well.

The distinction between communicative and elaborative idea integration has parallels to previous work that has measured integrative complexity (i.e., the degree to which reasoning involves recognizing (differentiation) and integrating multiple perspectives and possibilities and their interrelated contingencies) (Homan et al., 2007; Suedfeld et al., 1992). Assessments of integrative complexity as a single construct include varying levels of differentiation and integration (or the lack thereof). For instance, in a study on

State of the Union addresses from 41 U.S. presidents, Thoemmes and Conway (2007) used a single measurement construct that ranged from no indication of differentiation or integration (1) to clear indication of differentiation and integration (7).

In contrast, the results from our empirical analysis suggest that differentiation and integration actually constitute two facets of idea integration that one should treat differently when it comes to user interface design. In some instances, user comments demonstrated differentiation (communicative idea integration) only, while, in others, users' comments signaled both differentiation and integration (elaborative idea integration). Compared to elaborative idea integration, communicative idea integration corresponds to a lower level of integrative complexity where differentiation has begun to emerge or already exists but integration does not yet exist. Our results show strikingly complementary results for both types of idea integration (Figure 2), which represents one reason why we present the results for both types of integration separately. We present the model fit statistics in Table 5.

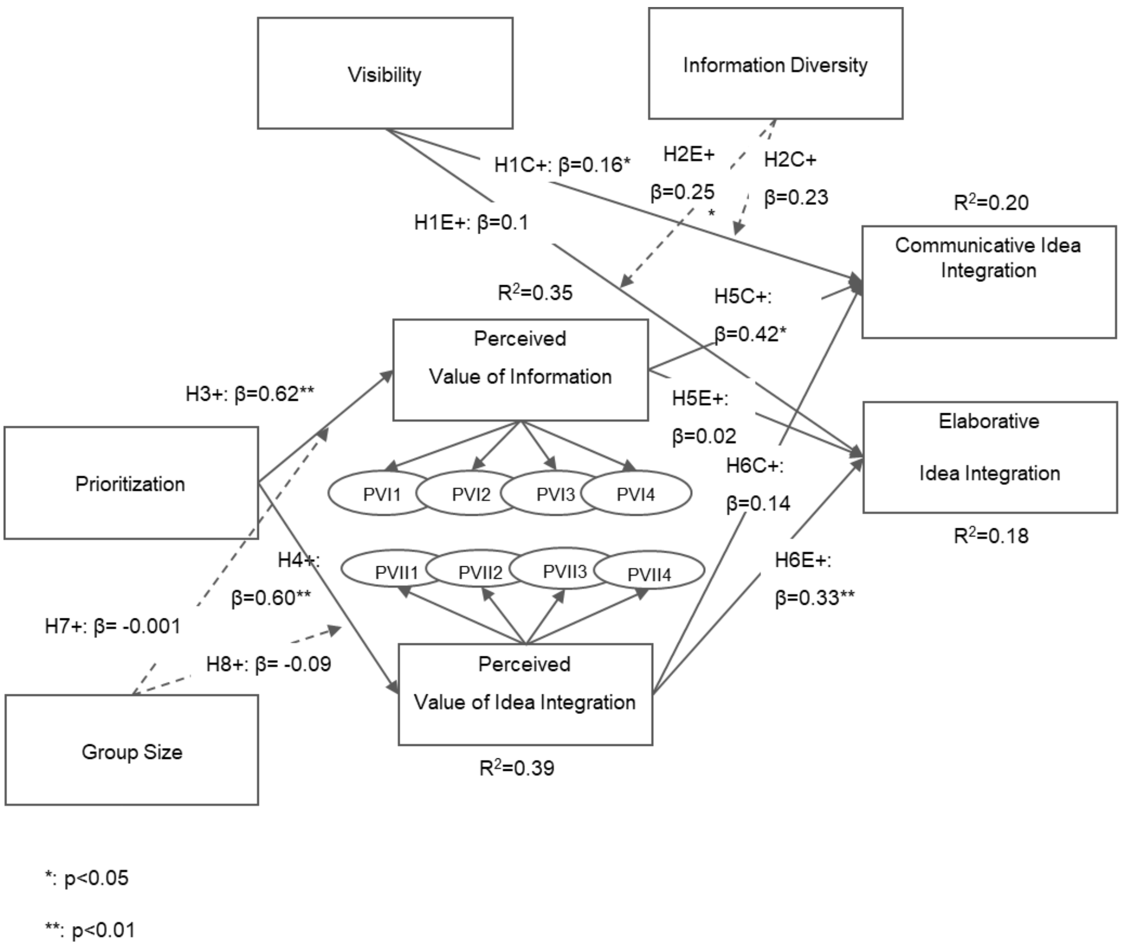

Figure 2. SEM Model

Table 5. Fit Statistics

Average path coefficient (APC)	.247; p = .009
Average R-squared (ARS)	.312; p = .002
Average variance inflation factor (AVIF) acceptable if ≤ 5; ideally ≤ 3.3	3.038
Tenenhaus GoF (GoF) Small ≥ 0.1; medium ≥ .25; large ≥ .36	.544
R-squared contribution ration (RSCR) Acceptable if ≥ 0.9; ideally = 1	.983

Regarding the model's fit statistics, researchers generally recommend that the p values be lower than 0.05 for the average path coefficient (APC) and the average R-squared (ARS). The average variance inflation factor (AVIF) should also not exceed 5 for models that fit well with the data (Kock, 2009). As Table 5 shows, the p values for the average path coefficient (APC) and the average R-Squared (ARS) were less than 0.05. The average variance inflation factor (AVIF) was lower than 5. All three fit indices for the model as Table 5 shows satisfy the requirements for a good fit (Kock, 2009). In Section 4.1, we describe and contrast the path coefficients for communicative and elaborative idea integration with respect to each hypothesis.

4.1 Measurement Model

We measured the two latent variables, perceived value of information and perceived value of idea integration, with four items each (PVI1-4 and PVII1-4, respectively) (see Table 6) as we describe in Section 3.6. To assess the reflective constructs' factorial validity, we conducted convergent and discriminant validity tests. Convergent validity refers to the extent to which items reflect one particular construct (Straub et al. 2004). Table 6 shows the loadings of the measurement items for both perceived value of information and perceived value of idea integration. The Cronbach's alpha was 0.861 for PVI and 0.898 for PVII. Composite reliability measures for PVI and PVII were 0.906 and 0.929, respectively.

Table 6. Factor Loadings

Measurement items	Label	Perceived value of information (PVI)	Perceived value of idea integration (PVII)
I am not sure that all the ideas that others contributed had much value.	PVI1	0.822	0.498
Some people did not post valuable ideas.	PVI2	0.911	-0.112
I am not sure I completely attributed value to every idea that was posted by others.	PVI3	0.796	-0.037
I am convinced that all the ideas everyone posted were valuable.	PVI4	0.830	0.107
Combining my ideas with ideas posted by others created better ideas.	PVII1	0.132	0.917
I am not sure if using ideas posted by others has helped me generate better ideas.	PVII2	0.010	0.883
I am convinced if I use ideas posted by other people, I can create better ideas.	PVII3	-0.094	0.826
Using other peoples' ideas has not helped me create better ideas.	PVII4	-0.059	0.873

The factor loadings (see Table 6) all exceeded the recommended threshold 0.5 ($P < .001$) (Hair, Anderson, & Tatham, 1987). Thus, we conclude that all measurement items, PVI1 to PVI 4 and PVII1 to PVII4, well represented their corresponding constructs perceived value of information and perceived value of idea integration, respectively. The reliability analysis showed that Cronbach's alpha was 0.861 for perceived value of information and 0.898 for perceived value of idea integration (number of cases: 226). The Cronbach's alpha values for both constructs exceeded the recommended threshold of 0.7 (Fornell & Larcker, 1981). The composite reliability was 0.906 for perceived value of information and 0.929 for perceived value of idea integration. Based on the above analysis, PVI1 to PVI4 exhibited acceptable convergence toward perceived value of information. Similarly, PVII1 to PVII4 exhibited acceptable convergence toward perceived value of idea integration.

Lastly, we examined discriminant validity for the two measurement items. Discriminant validity refers to the extent to which the various measurement items relate with the constructs they should reflect differently from their relations with all other items in the measurement model (Campbell & Fiske, 1959; Straub, Boudreau, & Gefen, 2004). Thus, to satisfy discriminant validity, the square root of the average variance extracted (AVE) for perceived value of information and perceived value of idea integration should be larger than any other correlation involving the two latent variables (Fornell & Larcker, 1981). We recorded an AVE of .840 for perceived value of information, which was higher than other correlations that involved perceived value of information (≤ 0.622). We also recorded an AVE of .875 for perceived value of idea integration, which was higher than any other correlation involving perceived value of idea integration (≤

0.593). The above test results suggest that the PVI1 to PVI4 and PVII1 to PVII4 measurement items distinctively reflected perceived value of information and perceived value of idea integration, respectively. As for discriminant validity between the two dependent constructs communicative and elaborative idea integration, we reviewed the square root of AVE for correlation (CII & EII) and found it was low at 0.094 (p = .461).

4.2 Structural Model

To examine the structural model, we looked at the path coefficients for all the structural links that we propose in our structural equation model. In this part of the analysis in particular, we found complementary results for communicative and elaborative idea integration (see Table 7).

First, in the SEM analysis, we found that the path coefficient for the link between idea visibility and communicative idea integration was significant ($\beta = 0.16$; $p < 0.05$), whereas the path coefficient for the link between idea visibility and elaborative idea integration was not significant ($\beta = 0.1$). These results indicate that, in our dataset, higher idea visibility was associated significantly and positively with communicative idea integration but not with the extent of elaborative idea integration. Thus, we found support for H1C but not H1E.

Second, information diversity did not have a significant moderating effect on the link between idea visibility and communicative idea integration (H2C) ($\beta = 0.23$). The same moderating effect, however, was significant for the link between idea visibility and elaborative idea integration (H2E) ($\beta = 0.25$, $p < 0.05$). In other words, the interaction effect of information diversity and idea visibility on idea integration was significant for elaborative idea integration but not significant for communicative idea integration. The significant effect of the interaction term information diversity x idea visibility implies that elaborative idea integration was associated with idea visibility only with high information diversity. Therefore, we found partial support for H2. In summary, information diversity moderates the relationship between idea visibility and idea integration such that the association of idea visibility and idea integration is stronger for higher levels of information diversity.

The path coefficients for the links between prioritization and perceived value of information ($\beta = 0.62$, $\rho < 0.01$) and perceived value of idea integration ($\beta = 0.60$, $\rho < 0.01$) were both significant, which supports H3 and H4.

The distinction between communicative idea integration and elaborative idea integration became evident once again when we analyzed the SEM results for H5 and H6. We found that communicative idea integration was positively and significantly associated with perceived value of information (H5C) ($\beta = 0.42$, $\rho < 0.05$), whereas the link between perceived value of information and elaborative idea integration was not significant (H5E) ($\beta = 0.42$). Therefore, we found support for H5C but not for H5E.

We also found that elaborative idea integration was associated positively and significantly with perceived value of idea integration (H6E) ($\beta = 0.33$, $\rho < 0.001$), yet the link between perceived value of idea integration and communicative idea integration was not significant (H6E) ($\beta = 0.14$). Therefore, we found support for H6E but not for H6C.

We found that group sized did not significantly moderate the link between prioritization and perceived value of information (H7) and between prioritization and perceived value of idea integration (H8) ($\beta = -.001$; $\beta = -0.09$). Therefore, we did not find support for H7 and H8.

Figure 4 depicts the relationship between perceived value of information and communicative idea integration, and Figure 5 depicts the relationship between the perceived value of idea integration and elaborative idea integration. As part of the WarpPLS, the algorithm normalized both values.

Table 7. Summary of Findings

	Perceived value of information	Perceived value of idea integration	Communicative idea integration	Elaborative idea integration
Visibility			H1C: β = 0.16*	H1E: β = 0.1
Prioritization	H3: β = 0.62**	H4: β = 0.60**		
Information diversity × Visibility			H2C: β = 0.23	H2E: β = 0.25*
Group size × Prioritization	H7: β = -0.001	H8: β = -0.09		
Perceived value of information			H5C: β = 0.42*	H5E: β = 0.02
Perceived value of idea integration			H6C: β = 0.14	H6E: β = 0.33**
*: < 0.05 - **: < 0.01				

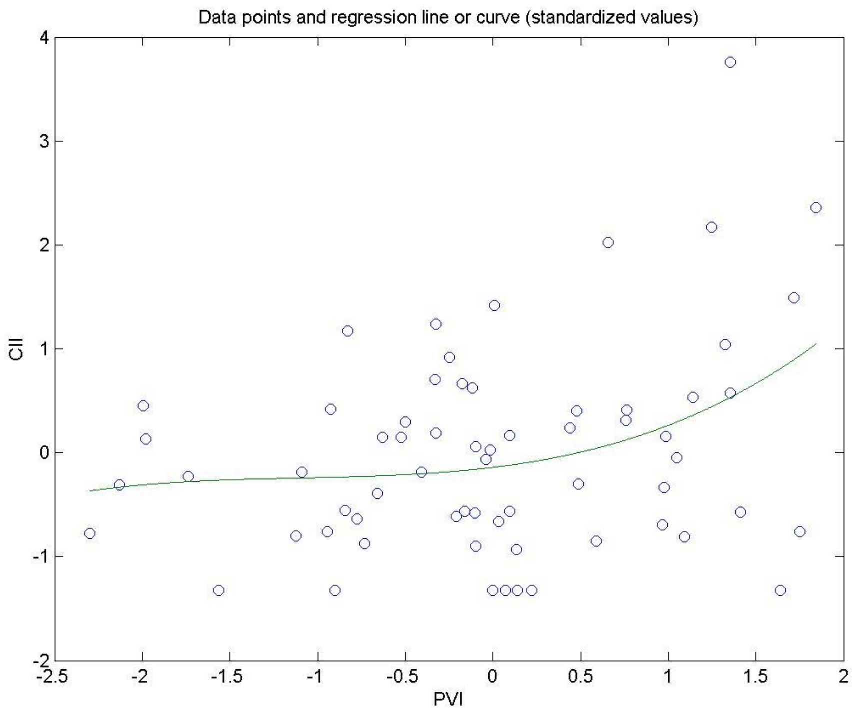

Figure 4. Functional Form between Perceived Value of Information (PVI) and Communicative Idea Integration (CII) (H5C)

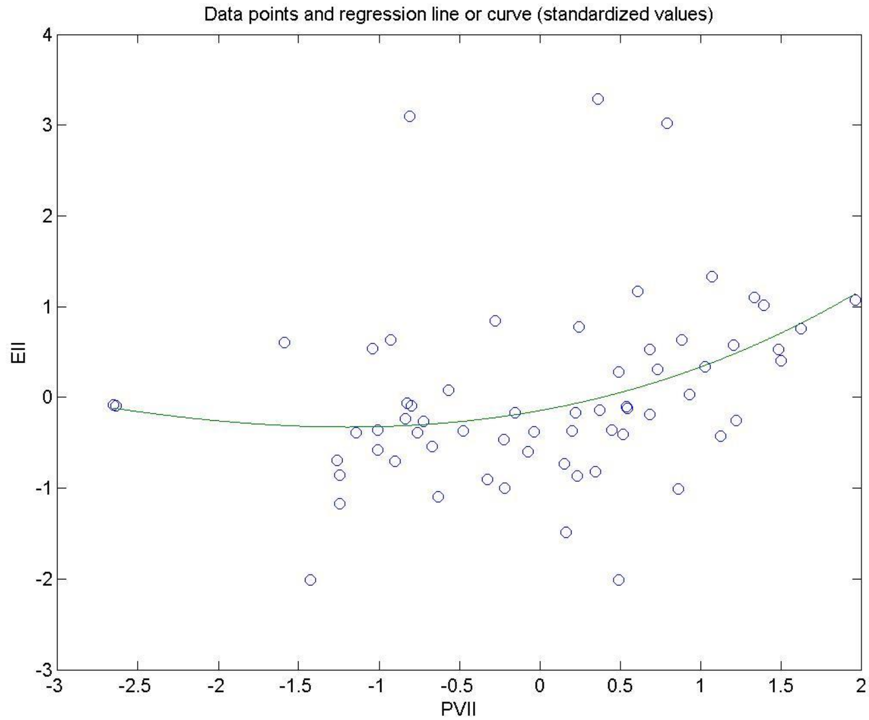

Figure 5. Functional Form between Perceived Value of Information (PVI) and Elaborative Idea Integration (EII) (H6E)

5 Discussion

As Figure 2 and Table 7 summarize, overall, we found partial support for our hypotheses overall. We found differences between communicative and elaborative idea integration whereby we note a remarkable complementarity between the results for both forms of idea integration in H1, H2, H4, and H5. For each of these four hypotheses, our data provides significant support for one form of idea integration but not the other.

Moreover, we also note differences in the indirect association between prioritization and the two forms of idea integration. Consistent with our research model, the association between prioritization and communicative idea integration emerged in two steps with perceived value of information as a mediator as we found support for both H3 and H5C (Figure 2). However, we did not find support for the same suggested mediating effect for perceived value of idea integration since our results supported only the suggested association between prioritization and perceived value of idea integration (H4) and not the association between value of idea integration and communicative idea integration (H6C). These findings may suggest that, despite whether individuals perceive idea integration as helping them generate better ideas, they will engage in communicative idea integration as long as they generally value the information in others' ideas. Therefore, to the extent that group facilitators believe in communicative idea integration to support group decision making and collaboration, facilitators needs to identify methods to signal the value of information in the shared ideas. In DSS, facilitators can accomplish such signaling via, for example, natural language processing tools (Losee, 2001) or other real-time facilitation mechanisms (Chen et al., 2007).

Again, the results for the indirect association between prioritization and elaborative idea integration complemented the results for the indirect association between prioritization and communicative idea integration. Here, we found that only for the links between prioritization, perceived value of idea integration (H4), and elaborative idea integration (H6E) supported both parts of the path. In contrast, we did not find support for perceived value of information's mediating effect as the association between prioritization and perceived value of information (H3) was significant but the association between perceived value of information and elaborative idea integration (H5E) was not. As for why, it may be that, despite the value they perceive others' ideas as having, individuals will engage in higher levels of idea integration as long as they perceive value in idea integration as such (H6E). Methods to enhance the perceived value of idea integration could include establishing norms, policies, and best practices that promote idea integration as a pro-social activity during the decision-making process (Yew, 2012).

The non-linear functional forms that Figures 4 and 5 depict highlight the critical roles that perceived value of information and perceived value of idea integration can play in enhancing communicative and elaborative idea integration, respectively. We found support for both links in our data set (H5C and H6E, see Table 7). Whereas previous studies on idea integration point to environmental factors, interventions, and group norms as relevant for an individual's disposition toward idea integration, we used collective prioritization, which research has commonly applied as a method to support verbal brainstorming, as an electronic user interface attribute and found a significant, yet somewhat complex, association between prioritization and idea integration. This finding suggests that one may require crowd-based mechanisms such as collaborative filtering or collaborative ratings to create efficient collaborative decision-making communities. To encourage a larger percentage of knowledge community members to engage in collaborative filtering, one could employ machine-learning tools and smart notifications to assure that individuals give all valid ideas a fair chance to survive through filtering mechanisms.

We did not find support for two hypotheses (H7 and H8), which posit that group size moderates the relationship between prioritization and perceived value of information (H7) and the relationship between prioritization and perceived value of idea integration (H8). Here, we need to note that, in large crowdsourcing initiatives, prioritization in the form of ratings might have a larger impact on which ideas the crowd attends to than in small settings (e.g., digg.com). Ratings in large idea pools effectively serve as collaborative filtering mechanisms that could immaturely filter good idea elements—ideas that, if integrated with other ideas, would create great solutions for the organization (Bjelland & Wood, 2008). We need more research to examine the role of group size and prioritization mechanisms in crowdsourcing platforms.

6 Conclusions

In this study, we examine potentially consequential interface-design elements for decision support tools (Hevner, March, Park, & Ram, 2004), especially those that support decision making in groups. We primarily focus on the decision-making phase during which individuals integrate facts and ideas to inform and justify a choice. We examine idea integration through an attention-based lens and empirically investigate the relation between two user interface features (visibility and prioritization) and idea integration.

6.1 Implications for Theory

While the results of the empirical study generally support the attention-based view of idea integration and its suggested antecedents, they also suggest a need to refine the commonly used construct idea integration (Javadi et al., 2013). Specifically, the analysis points to integration complexity as an important characteristic to distinguish between different idea-integration levels, which we apply in this paper as communicative and elaborative idea integration. The results for both types of idea integration largely complement each other and scarcely overlap. The theoretical base we use in this study—the attention-based view of idea integration and its underlying frameworks, the cognitive network model (CNM) of creativity (Santanen et al., 2004) and ability and motivation framework (e.g., Thoemmes & Conway, 2007)—does not fully explain communicative and elaborative idea integration. Instead, our empirical results suggest a need to broaden the theoretical base and to include concepts, such as integrative complexity, to better understand idea integration and its antecedents (Baker-Brown et al., 1992). The associations between idea integration and distinct cognitive, ability, and motivational factors appear to be more complex than what many researchers have commonly assumed. Therefore, future theoretical investigations that explain the antecedents of idea integration should consider the variations of integration complexity and the resulting implications and further explore the construct as such.

Also, theories on knowledge creation must examine both knowledge sharing and knowledge integration. Our findings complement findings in the literature on information sharing (e.g., Wasko & Faraj, 2005). While the extant literature on groups and communities has tended to focus on identifying determinants of and obstacles to knowledge sharing, we establish knowledge integration as an indispensable phenomenon that enables collaborative knowledge creation. Similar to other studies that we list in Table 1, in this study, we adopt the premise that, without integration, individuals cannot realize idea sharing's true value. Individuals may never discover shared but less developed ideas with valuable dimensions or integrate them with other ideas to create exceptional ideas if proper incentives for knowledge integration do not exist. To examine and design incentive mechanisms for knowledge integration, we need to better understand the underpinnings of idea integration. The empirical support we found for a distinction between communication and elaborative knowledge integration represents a step toward that goal.

Both communicative and elaborative idea integration play a role in fostering innovation and creativity, and ideation requires both forms of idea integration at different phases. Communicative idea integration, which individuals need in earlier ideation stages, helps them to identify and acknowledge new idea dimensions. In contrast, elaborative idea integration, which individuals need in later ideation phases, allows individuals to create and articulate previously undiscovered links among different ideas. Studies that theoretically examine creativity in groups, communities, and in the workplace must take a fresh look at the problem at hand and consider that idea integration takes different forms and that idea dimensions, not ideas, represent creativity's building blocks.

Similarly, we suggest that future human-computer interaction research that draws on research from IT, cognitive psychology, and other social sciences recognize idea dimensions and different and new forms of integration as they work on formulating the impact that perceptive, cognitive, and social factors have on individuals' tendency to engage in idea integration.

6.2 Implications for Practice

Management researchers have emphasized the importance of knowledge integration as a basis for developing knowledge-based capabilities in firms. Without knowledge integration at the group level, firms cannot harness the true value of knowledge that individuals possess (Grant 1996a, 1996b). Many organizations strive to promote knowledge integration in and beyond organizational boundaries (e.g., crowdsourcing). In higher education, educators promote learners to synthesize ideas and learn from their peers by using online discussion forums (Waters & Gasson, 2012). In short, effective peer learning, decision making, and innovation requires idea integration.

To the extent that idea integration impacts innovation in open communities and organizational settings, designers and moderators must recognize the value of the different types of idea integration and design incentives and tools accordingly. While platforms that enable individuals to share fully developed ideas appear to best support collaborative idea integration, platforms that enable and encourage individuals to share partially developed ideas seem to best support elaborative idea integration. Managers must identify the type of idea integration that would most benefit the ideation efforts they undertake and design employee rewards and ideation mechanisms accordingly. When developing GDSS to support idea integration, designers should first carefully delineate the form of idea integration that best fits the task at hand and then create IS platforms and interfaces to support it. Designers should tailor automatic incentive mechanisms (e.g., points for new ideas or comments), automatic or collaborative filtering tools, and automatic notification mechanisms to the desired type of idea integration.

As an example, our results suggest that exposing decision makers to more ideas may have limited benefit in situations where decision quality depends on elaborative idea integration (Chapman & Johnson, 1994; Tversky & Khaneman, 1974). Merely exposing decision makers to more ideas (visibility) might not sufficiently help them reach high-quality decisions or solve difficult problems—they also need diverse ideas.

Also, the significant interaction effect between visibility x information diversity and elaborative idea integration that we found suggests a need to tailor the rate with which DSS present users with new and diverse ideas or system-produced cues to possible integrative ideas. Thus, exposing decision makers to a shuffled and condensed yet diverse set of ideas may particularly help them achieve elaborative idea integration. In practice, ensuring diversity precludes prematurely filtering ideas (e.g., based on quality). Search and comparison tools (e.g., in TeamSpirit) can help with identifying unique or diverse ideas. Text-mining tools also constitute key components for evaluating similarities and dissimilarities among text-based ideas.

Similarly, the targeted type of idea integration can inform the idea-sharing tools that groups choose, such as the relay versus decathlon method or pool-writing versus gallery-writing techniques (Aiken, Vanjani, & Paolillo, 1996; De Vreede, Davison, & Briggs, 2003; Robert & Dennis 2005; De Vreede et al., 2010). For example, the relay method may support elaborative idea integration as it requires subgroups to engage in the ideation process in a serial manner and each subgroup to start the ideation process with the pool of previously generated ideas, which encourages each subgroup to process previously generated ideas

(Vreede et al. 2000, 2010). In contrast, the decathlon method might better support communicative idea integration because all subgroups ideate in parallel, which limits the diversity in ideas that each individual sees.

Perceiving value in other people's ideas may motivate an individual to refer to, acknowledge, or criticize those ideas, but unless the individual perceives idea integration to have value, the individual might not provide additional elaboration. In contrast, if individuals believe idea integration to have value, they might take the necessary steps to elaborate or evolve the ideas that others share regardless of the value they perceive those ideas to have. Our results suggest that the perceived value of the others' ideas and perceived value of integration may actually involve different cognitive processes. The disparity may arise from 1) platform features (users may post only fully developed ideas, which limits the opportunities for elaborative idea integration), 2) individual information-processing styles and decision-making biases, 3) incentive mechanisms (rewards for new ideas or for collaboratively evolving existing ideas), and 4) individuals' intrinsic motivation and philosophies on collaborative processes and outcomes. Of those four possible factors, designers can directly address the first three when designing systems.

The distinction can help organizations direct their organizational resources toward improving what would most benefit their performance at each phase in their life. For instance, a startup organization may find particularly benefit from establishing communicative integration. However, as the organization and its constituting processes mature, it may find that elaborative idea integration contributes more to its sustained growth. Making ideas visible may be more important during the initial stages of an organization's development, but prioritizing ideas and improving the visibility of the most valuable ideas may become an essential activity during more mature stages.

The mixed associations between idea visibility and prioritization on the one hand and the different types of idea integration on the other hand support one reason why we conducted this study: to better understand and measure idea integration that we can apply to collaborative decision-making situations, such as design evolution that crowdsourcing platforms enable.

6.3 Limitations

Undoubtedly, using controlled experiments with participants from a student population poses some limitations to our findings' generalizability. Thus, to extend their generalizability, other researchers could corroborate our findings in organizational settings or in open platforms where competition, organizational dynamics, and other social factors impact decision making and attitudes toward knowledge integration. Given that organizations and individuals pervasively use collaborative platforms and social media today, researchers also need to examine the impact that interactions (structure and dynamic) have on individuals' integration behavior. Depending on the extent and depth of the expertise required for brainstorming sessions, researchers may treat group size as an interval (not categorical) variable. In highly specialized knowledge intensive tasks, adding a single participant may indeed change the dynamics of idea generation and the integration process. Prior research studies have examined how individuals' capabilities can impact idea generation's outcomes (Valacich et al., 2006). An analysis at a group level, as we perform in our study, does not provide insights about variations at the individual level, which represents a limitation. In addition, previous studies have examined how familiarity and group social ties may interact with the cognitive processes (Gruenfeld, Mannix, Williams, & Neale, 1996; Goodman & Leyden, 1991) that underlie idea integration. Future theoretical and empirical examinations must assess how different individual, social, organizational, and technological factors interact to influence different forms of idea integration.

Although we identified two types of elaborative idea integration (Table 4), we did not fully distinguish between both in our empirical model and examine them in the same construct. Future research studies may want to address this limitation by identifying different ways in which brainstormers integrate ideas (e.g., additive, improving, synergistic). Future laboratory and field experiments must focus on further differentiating between different types of elaborative idea integration because they do not all require the same level of perceptive and cognitive effort, nor do social and organizational factors likely impact them all in the same way.

6.4 Outlook

The ramifications of our results reach further than the experiments we describe here. Depending on the desired type of idea integration, designers of future DSS, EBS, creativity support tools, crowdsourcing platforms, and systems alike may choose to selectively expose participants to different subsets and portions of ideas or facts. Selective exposure, however, requires multi-level balanced learning bases for it to counter negative effects, such as a premature focus on a few salient ideas. Any machine-based approach to selectivity can create a limited perspective about the issues that individuals deal with in reality. Consequently, every effort to enhance effective integration through using technology or algorithms must recognize the dangers of machine-enabled selectivity.

Designers can apply the associations between user interface characteristics and idea integration that we examine in this study when designing decision support systems that improve the quality of decisions and judgments in organizations. Consciously crafting user interfaces that consider idea diversity, rate of exposure, form, visibility, prioritization, and rewards for different types of idea integration promises new pathways for designing decision support systems.

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References

Aiken M., Vanjani, M., & Paolillo, J. (1996). A comparison of two electronic idea generation techniques. *Information and Management*, *30*(2), 91-99.

Atkinson, R. C., & Shiffrin, R. M. (1968), Human memory: A proposed system and its control. *Psychology of Learning and Motivation*, *2*, 89-195.

Baker-Brown, G., Ballard, E. J., Bluck, S., de Vries, B., Suedfeld, P., & Tetlock, P. E. (1992). The conceptual integrative complexity scoring manual. In C. P. Smith, J. W. Atkinson, D. C. McClelland, & J. Veroff (Eds.). *Motivation and personality: Handbook of thematic content analysis* (pp. 393-400). Cambridge, UK: Cambridge University Press.

Bjelland, O. M., & Wood, R. C. (2008). An inside view of IBM's "Innovation Jam". *MIT Sloan Management Review, 50*(1), 32-40.

Bragge, J., Tuunanen, T., Virtanen, V., & Svahn, S. (2012). Designing a repeatable collaboration method for setting up emerging value systems for new technology fields. *Journal of Information Technology Theory and Application, 12* (3), 27-47.

Briggs, R. O. (2006). On theory driven design and deployment of collaboration systems. *International Journal of Human-Computer Studies*, *64*(7), 573-582.

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin*, *56*(2), 81-105.

Chapman, G. B., & Johnson, E. J. (1994). The limits of anchoring. *Behavioral Decision Making*, *7*(4), 223-242.

Chen, M., Liou, Y., Wang, C.-W., Fan, Y.-W., & Chi, Y.-P. J. (2007). TeamSpirit: Design, implementation, and evaluation of a Web-based group decision support system. *Decision Support Systems*, *43*(4), 1186-1202.

Dennis, A. R. (1996). Information exchange and use in group decision making: You can lead a group to information, but you can't make it think. *MIS Quarterly*, *20*(4), 433-457.

Dennis, A. R., Valacich, J.S., Connolly, T., & Wynne, B. E. (1996). Process structuring in electronic brainstorming. *Information Systems Research*, *7*(2), 268-277.

Dennis, A. R., & Valacich, J. S. (1999). Electronic brainstorming: Illusions and patterns of productivity. *Information Systems Research*, *10*(4), 375-377.

Dennis, A. R., & Wixom, B.H. (2001). Investigating the moderators of the group support systems use with meta-analysis. *Journal of Management Information Systems*, 18(3), 235-257.

DeSanctis G., & Gallupe, R. B. (1987). A foundation for the study of group decision support systems. *Management Science*, *33*(5), 589-609.

DeVellis, R. F. (2012). *Scale development: Theory and applications*. Thousand Oaks, CA: Sage.

De Vreede, G. J., Briggs, R. O., van Duin, R., & Enserink, B. (2000). Athletics in electronic brainstorming: Asynchronous electronic brainstorming in very large groups. In *Proceedings of the 33rd Hawaiian International Conference on Systems Sciences*.

De Vreede, G. J., Briggs, R. O., & Reiter-Palmon, R. (2010). Exploring asynchronous brainstorming in large groups: A field comparison of serial and parallel subgroups. *Human Factors*, *52*(2), 189-202.

De Vreede, G. J., Davison, R. M., & Briggs, R. O. (2003). How a silver bullet may lose its shine. *Communications of the ACM*, *46*(8), 96-101.

Dyer, W. G. (1987). *Team building: Issues and alternatives* (2nd ed.). Reading, MA: Addison-Wesley.

Ferran, C., & Watts, S. (2008). Videoconferencing in the field: A heuristic processing model. *Management Science*, *54*(9), 1565-1578.

Fjermestad, J., & Hiltz, S. R. (1999). An assessment of group support systems experimental research: Methodology and results. *Journal of Management Information Systems*, *15*(3), 7-149.

Fjermestad, J., & Hiltz, S. R. (2001). A descriptive evaluation of group support systems case and field studies. *Journal of Management Information Systems*, *17*(3), 115-159.

Fornell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39-50.

Gallupe, R. B., Dennis, A. R., Cooper, W. H., Valacich, J. S., Bastianutti, L. M., & Nunamaker, J. F. (1992). Electronic brainstorming and group size. *Academy of Management Journal*, *35*(2), 350-369.

Gefen, D., Straub, D., & Boudreau, M.-C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, 1, 1-79.

Goodman, P. S. & Leyden, D. P. (1991). Familiarity and group productivity. *Journal of Applied Psychology*, 76(4), 578–586.

Grant, R. M. (1996a). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, *17*(S2), 109-122.

Grant, R. M. (1996b). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science*, *7*(4), 375-387.

Gruenfeld, D. H., & Hollingshead, A. B. (1993). Sociocognition in work groups—the evolution of group integrative complexity and its relations to task-performance. *Small Group Research*, *24*(3), 383-405.

Gruenfeld, D. H., Mannix, E. A., Williams, K. Y., & Neale, M. A. (1996). Group composition and decision making: How member familiarity and information distribution affect process and performance. *Organizational Behavior and Human Decision Processes*, *67*(1), 1-15.

Hair, J., Anderson, R., & Tatham, R. (1987). *Multivariate data analysis*. New York, NY: Macmillan.

Hansen, M. T., & Haas, M. R. (2001). Competing for attention in knowledge markets: Electronic document dissemination in a management consulting company. *Administrative Science Quarterly*, *46*(1), 1-28.

Harrison, D. A., & Klein, K. J. (2007). What's the difference? Diversity constructs as separation, variety, or disparity in organizations. *Academy of Management Review*, *32*(4), 1199-1228.

Hevner, A., March, S., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly, 28*(1), 75-105.

Homan, A. C., Van Knippenberg, D., Van Kleef, G. A., & De Dreu, C. K. W. (2007). Bridging fault lines by valuing diversity: Diversity beliefs, information elaboration, and performance in diverse work groups. *Journal of Applied Psychology*, *92*(5), 1189-1199.

Javadi, E., Gebauer, J., & Mahoney, J. T. (2013). The impact of user interface design on idea integration in electronic brainstorming: An attention-based view. *Journal of the Association for Information Systems*, *14*(1), 1-21.

Johnson, D. W., & Johnson, F. P. (1982). *Joining together: Group theory and group skills* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Kock, N. (2009). WarpPLS 1.0 user manual. *ScriptWarp Systems*. Retrieved from http://www.scriptwarp.com/warppls/UserManual_WarpPLS_V3_Redirect.pdf

Landauer, T. K., Foltz, P. W., & Laham, D. (1998). Introduction to latent semantic analysis. *Discourse Processes*, *25*(2-3), 259-284.

Litchfield, R. C. (2008). Brainstorming reconsidered: A goal-based view. *Academy of Management Review*, *33*(3), 649-668.

Losee, R. M. (2001). Natural language processing in support of decision-making: Phrases and part-of-speech tagging. *Information Processing and Management*, *37*(6), 769-787.

Madsen, T., Woolley, J., & Sarangee, K., (2012). Using internet-based collaboration technologies for innovation: Crowdsourcing vs. expertsourcing. In *Proceedings of the Academy of Management Annual Meeting*.

Majchrzak A., & Malhotra, A. (2013). Towards an information systems perspective and research agenda on crowdsourcing for innovation. *Journal of Strategic Information Systems*, *22*(4), 257-268.

March, J. G., & Simon, H. A. (1958). *Organization*. New York, NY: John Wiley.

Mennecke, B. E. (1997). Using group support systems to discover hidden profiles: An examination of the influence of group size and meeting structures on information sharing and decision quality. *International Journal of Human-Computer Studies*, *47*(3), 387-405.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information*. Psychological Review, 63(2), 81-97.*

Ocasio, W. (1997). Towards an attention-based view of the firm. *Strategic Management Journal*, *18*(S1), 187-206.

Okhuysen, G. A., & Eisenhardt, K. M. (2002). Integrating knowledge in groups: How formal interventions enable flexibility. *Organization Science*, *13*(4), 370-386.

Petty, R. E., & Cacioppo, J. T. (1986). *Communication and persuasion*. New York, NY: Springer.

Pinsonneault, A., Barki, H., Gallupe, R. B. & Hoppen, N. (1999). Electronic brainstorming: The illusion of productivity. *Information Systems Research*, *10*(2), 110-133.

Potter, R. E., & Balthazard, P. (2004). The role of individual memory and attention processes during electronic brainstorming. *MIS Quarterly*, *28*(4), 621-643.

Reinig, B. A., Briggs, R. O., & Nunamaker, J. F. (2007). On the measurement of ideation quality. *Journal of Management Information Systems*, *23*(4), 143-161.

Robert, L. P., & Dennis, A. R. (2005). The paradox of richness: A cognitive model of media choice. *IEEE Transactions on Professional Communication*, *48*(1), 10-21.

Robert, L. P., Dennis, A. R., & Ahuja, M. K. (2008). Social capital and knowledge integration in digitally enabled teams. *Information Systems Research*, *19*(3), 314-334.

Santanen, E. L., Briggs, R. O., & De Vreede, G. J. (2004). Causal relationships in creative problem solving: Comparing facilitation interventions for ideation. *Journal of Management Information Systems*, *20*(4), 167-197.

Siangliulue, P., Chan, J., Huber, B., Dow, S. P., & Gajos, K. Z. (2016). Ideahound: Self-sustainable idea generation in creative online communities. In *Proceedings of the 19th ACM Conference on Computer Supported Cooperative Work and Social Computing Companion* (pp. 98-101).

Simon, H. A. (1947). *Administrative behavior: A study of decision-making processes in administrative organization*. New York, NY: Macmillan.

Straub, D., Boudreau, M. C., & Gefen, D. (2004). Validation guidelines for IS positivist research. *Communications of the Association for Information Systems*, 13(1), 380-427.

Suedfeld, P., Tetlock, P. E. & Streufert, S. (1992). Conceptual/integrative complexity. In C. P. Smith, D. C. Atkinson, C. McClelland, & J. Veroff (Eds.), *Motivation and personality: Handbook of thematic content analysis* (pp. 393-400), Cambridge, NY: Cambridge University Press.

Sussman, S. W., & Siegal, W. S. (2003). Informational influence in organizations: An integrated approach to knowledge adoption. *Information Systems Research*, *14*(1), 47-65.

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction*, *4*(4), 295-312.

Thoemmes, F. J., & Conway, L. G. (2007). Integrative complexity of 41 US presidents. *Political Psychology*, *28*(2), 193-226.

Tversky, A., & Khaneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4517), 1124-1131.

Valacich, J. S., Wheeler, B. C., Mennecke, B. E., & Wachter, R. (1995). The effects of numerical and logical group-size on computer-mediated idea generation. *Organizational Behavior and Human Decision Processes*, *62*(3), 318-329.

Valacich, J. S., Jung, J. H., & Looney, C. A. (2006). The effects of individual cognitive ability and idea stimulation on idea-generation performance. *Group Dynamics*, *10*(1), 1-15.

Van Knippenberg, D., De Dreu, C. K. W., & Homan, A. C. (2004). Work group diversity and group performance: An integrative model and research agenda. *Journal of Applied Psychology*, *89*(6), 1008-1022.

Waters, J., & Gasson, S. (2012). Using asynchronous discussion boards to teach IS: Reflections from practice. In *Proceedings of the 32nd International Conference on Information Systems*.

Wasko, M. M., & Faraj, S. (2005). Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. *MIS Quarterly*, *29*(1), 35-57.

Yew, J. (2012). *Social performances: A sociotechnical framework for understanding online prosociality* (doctoral thesis). University of Michigan, Michigan.

About the Authors

Elahe Javadi is an *Assistant Professor* of Information Technology at Illinois State University. In her research, she has examined idea integration enablers and obstacles by applying different lenses such as attention-based view, social networks, intellectual property rights, and selectivity. Her research studies have been published or presented in such journals as *Journal of Association for Information Systems* and *Information Systems Educators Journal.*

Judith Gebauer is a Professor of Information Systems at the University of North Carolina Wilmington. Her research focuses on the design, management, and implications of business information systems, as well as on IS education. Her work has been published in such journals as *Decision Support Systems*, *Journal of Information Technology*, *Journal of the Association for Information Systems*, and *Communications of the ACM*.

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