The Impact of User Interface Design on Idea Integration in Electronic Brainstorming: An Attention−Based View

Elahe Javadi
University of Illinois at Urbana−Champaign, College of Business

Judith Gebauer
University of North Carolina at Wilmington, Cameron School of Business

Joseph T. Mahoney
University of Illinois at Urbana−Champaign, College of Business

Abstract

This paper introduces an attention−based view of idea integration that underscores the importance of IS user interface design. The assumption is that presenting ideas via user interface plays a key role in enabling and motivating idea integration in electronic brainstorming (EBS), and thus advances productivity. Building upon Cognitive Network Model of Creativity and ability−motivation framework, our attention−based theory focuses on two major attributes of user interface: visibility and prioritization. While visibility enables idea integration via directing attention to a limited set of ideas, prioritization enhances the motivation for idea integration by providing individuals with a relevant and legitimate proxy for value of the shared ideas. The theory developed in this paper is distinct from previous research on EBS in at least two ways: (1) this theory exclusively focuses on idea integration as the desired outcome and studies it in the context of IS user interface; and (2) rather than debating whether or not EBS universally outperforms verbal brainstorming, the proposed theory revisits the links between user interface and idea integration as an attention−intensive process that contributes to EBS productivity. Idea integration by individuals within a group is an essential process for organizational creativity and thus for establishing knowledge−based capabilities. Lack of such integration significantly reduces the value of idea sharing, which has been a predominant focus of the EBS literature in the past. The current theory posits that the ability of electronic brain−storming to outperform nominal or verbal brainstorming depends on its ability to leverage information system (IS) artifact capabilities for enhancing idea integration to create a key pattern of productivity. The developed theory provides a foundation for new approaches to EBS research and design, which use visibility and prioritization, and also identify new user interface features for fostering idea integration. By emphasizing idea integration, designers and managers are provided with practical, cognition−based criteria for choosing interface features, which can improve EBS productivity. This theory also has implications for both the practice and research of knowledge management, especially for the attention−based view of the organization.

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An Attention-Based View

Elahe Javadi
Department of Business Administration
College of Business
University of Illinois at Urbana-Champaign
350 Wohlers Hall
1206 South Sixth Street
Champaign, IL 61820
ejavadi2@illinois.edu

Judith Gebauer
Associate Professor of Information Systems
Department of Information Systems and Operations Management
Cameron School of Business
University of North Carolina at Wilmington
601 South College Road
Wilmington, NC 28403-5920
gebauerj@uncw.edu

Joseph T. Mahoney
Professor of Business Administration
Caterpillar Professor in Business, &
Director of Graduate Studies
Department of Business Administration
College of Business
University of Illinois at Urbana-Champaign
140C Wohlers Hall
1206 South Sixth Street
Champaign, IL 61820
josephm@illinois.edu

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Keywords: Idea integration, visibility, prioritization, attention-based view

Introduction

Despite the pervasive use of electronic media for group brainstorming, evidence from research and practice suggests that electronic brainstorming systems (EBSs) may have created an illusion of productivity, offering limited benefits in terms of quantity or quality of the ideas generated by individuals during the brainstorming process (Fjermestad & Hiltz 1999, 2001). *Brainstorming* here is defined as generating, sharing, and combining ideas or solutions on a problem or task by more than one individual (Shepherd *et al.* 1996; Reinig *et al.* 2007). An experimental study at Sandia National Laboratories (Davidson *et al*. 2007), for instance, found that individuals working alone outperformed those working in groups in terms of the quantity of ideas generated and the extent of the elaboration on each idea. Similar research studies also examine the EBS productivity illusion in terms of process gains such as cognitive stimulation and synergy, and process losses such as cognitive interference (Pinsonneault *et al.* 1999).

Examples of process gains in electronic brainstorming that have been corroborated in empirical studies are elimination of production blocking, alleviating evaluation apprehension in anonymous EBSs, and tackling social loafing through use of technology for realizing some forms of social comparison (de Vreede & Dickson 2000; Fjermestad & Hiltz 2001; Briggs 2006). Shepherd and colleagues (1996), for instance, reported a 63% increase in the number of unique ideas generated during a brainstorming session when a highly salient social comparison mechanism was utilized in the brainstorming.

Some research studies, however, suggest that process losses may outweigh process gains in electronic brainstorming (Pinsonneault *et al.* 1999). An underpinning thesis for losses during electronic brainstorming is associated with attentional processes. Losses that arise from inefficient attentional processes are two-fold: (1) loss may be caused by attention diversion because of excessive exposure to other people's ideas, or (2) loss may be caused by lack of

attention to other people's ideas. The quest for finding optimal attention, in which process losses are restrained and EBS productivity is improved, motivates the current paper's theory development. We suggest that EBS productivity can be examined through theoretical framings for IS artifact design with respect to managing underpinning attentional processes in brainstorming. Technology-independent IS design features derived from such a theory can inform IS user interface design (Briggs 2006).

The theory developed here underscores the ability of IS user interface (UI) design to advance EBS productivity with an emphasis on idea integration as the desired outcome. The extant IS research literature on idea integration has proven its relevance to and importance for the overall productivity of EBS (Dennis 1996; de Vreede *et al.* 2000; Robert *et al.* 2008; Sussman & Siegal 2003). Further, organization science research has shown that the ability of an organization to appropriate the value of knowledge owned and accumulated by individuals depends on its ability to encourage idea integration within groups (Okhuysen & Eisenhardt 2002). Idea integration within groups initiated by heterogeneous, diverse, and specialized individuals is essential for creating knowledge-based capabilities of an organization (Grant 1996b; Kogut & Zander 1992; Santanen *et al.* 2004). EBS is an ideal locus for supporting idea integration since electronic media has become a prevalent platform for communication among individuals within and across organizations.

With few exceptions (e.g., de Vreede *et al.* 2003; 2010, see Table 1 on page 6), however, the dominant focus in EBS research has been on idea sharing determinants and detriments, with little consideration for the ultimate goal for shared ideas to be integrated and used by others (Zhang & Watts 2008). In the broader literature on brainstorming, for example, when comparing productivity of nominal brainstorming (individuals ideate on a problem separately) with that of

verbal brainstorming (brainstorming: individuals ideate on a problem collaboratively in groups), idea integration is not always regarded as an essential measure of brainstorming productivity (Fjermestad & Hiltz 1999, 2001). Similarly, in EBS research literature, when comparing verbal brainstorming to electronic brainstorming, the main foci are idea generation and sharing. Typically, less attention has been given to idea integration and to leveraging IS capabilities; particularly user interface for supporting idea integration. It should also be noted that, in general, antecedents of idea integration differ from but sometimes overlap with those of idea generation and sharing (de Vreede *et al.* 2003; Santanen *et al.* 2004).

In contrast, some research regards idea integration as an important primary contributor to productivity gains in groups (de Vreede *et al.* 2003). For example, several experimental studies have addressed individual idea integration behavior and measured the extent to which individuals build on the ideas shared by others (Dennis 1996; Robert *et al.* 2008; Vreede *et al.* 2010). Others have examined productivity implications of idea integration for electronic groups (Vreede *et al.* 2003, 2010).

To bridge the identified gap in the research literature, our proposed theory focuses particularly on idea integration for achieving EBS productivity advantages in comparison with verbal and nominal brainstorming (Dennis 1996; Homan *et al.* 2007; Robert *et al.* 2008). For accomplishing EBS productivity superiority through the advancement of idea integration, IS interface features are crucial for channeling individuals' attention and for enabling and motivating idea integration.

The proposed theory builds upon an *attention-based view* of user interface influence on idea integration (Simon 1947; Ocasio 1997). It builds upon the Cognitive Network Model of creativity (Santanen *et al.* 2004) and adopts a *motivation-ability* approach to interface design

(Santanen *et al*. 2004; Robert & Dennis 2005; Thoemmos & Conway 2007). For ideas to be integrated they must be exposed to individuals' attention; individuals must create the connections among different ideas, thus they must be able and motivated to do so. Since the IS user interface is the main point of access to the shared ideas for individuals in EBS (Sheppard & Rouff 1994), user interface features play a key role in enhancing individuals' abilities and motivations for idea integration (Dennis *et al.* 2001). This paper's theory posits that channeling attention (i.e., directing individuals' attention) through manipulation of visibility of the ideas (i.e., information saliency) (Briggs 1995) and prioritization of ideas (Dennis 1996) influence individuals' idea integration behavior. The developed theory thus accounts for underpinning processes for idea integration and uses the IS artifact as an instrument to cultivate the potentials for idea integration (Briggs 2006). To summarize, the attention-based view of IS user interface design for enhanced idea integration is based on the following premises:

1. Individuals' idea integration behavior in electronic brainstorming depends on the extent and quality of attention allocated to the ideas shared by others (Simon 1947; Ocasio 1997);

2. Attending to the shared ideas lead to retrieval and activation of related concepts which advances potentials for idea integration (Santanen *et al*. 2004); and

3. Since the IS user interface is the main point of access to the shared ideas, attention can be managed by employing user interface features to enable and motivate idea integration (Suedfeld *et al.* 1992; Thoemmos & Conway 2007).

The proposed theory is technology-free in that the effect of the independent constructs (i.e., *visibility* and *prioritization*) on idea integration is explained through the processes that shape idea integration behavior rather than a specific technological implementation of them (Briggs 2006). Although specific IS artifact instances may implement this theory's constructs in different ways, we maintain that the general features of IS artifacts as represented in our constructs are core to realizing the attentional processes that lead to idea integration.

The theory developed here contributes to the IS research literature on EBS and idea creation in at least three ways. First, building upon Simon's (1947) logic for attention as a scarce resource in organizations, this theory links IS interface attributes to the creation of organizational knowledge-based capabilities in an era of collaboration technologies' prevalence (McAfee 2006). Second, building upon the EBS literature, it extends the use of interface attributes for enhancing brainstorming productivity through promoting idea integration (Dennis *et al.* 1996; de Vreede *et al.* 2003). Third, it creates the foundation for empirical studies that contribute to technology design and managerial decision making regarding the choice of technologies to improve collaboration and knowledge creation within organizations (Briggs 2006; Zhang & Watts 2008). Examining idea integration in electronic settings using the current paper's developed theory can also contribute to the resolution of the paradox of electronic brainstorming productivity by providing new instruments for improving productivity.

The guidelines derived from our theory for electronic brainstorming design will apply to computer-supported-communication (CMC) in any context where knowledge creation is the goal. More specifically, we regard EBSs as instances of CMCs that generally support idea sharing within groups (Fjermestad & Hiltz 2001). In addition to idea sharing, our theory proposes methods for making EBSs in particular and CMCs in general more amenable to idea integration. The propositions derived from our theory are testable in field or laboratory experiments.

Since IS theories are expected to focus on technology-supported processes rather than just the technology (Briggs 2006), we first expand on idea integration process and dynamics. We note the links between knowledge integration and EBS productivity and we proceed to present our attention-based view of idea integration. We then consider the links between IS user

interface features and idea integration (Mitchell 2006) and the remainder of the paper conceptualizes each of the constructs in our theory.

Idea Integration and Electronic Brainstorming Productivity

The brainstorming process involves the generation, exchange and individual-level processing of ideas, discussing the results of the individual-level processing within the group, leading to the integration of the ideas (Homan *et al*. 2007). Assuming that no one individual has sufficient information to generate the best idea, idea integration becomes a key to realizing more fully the value of the individually generated ideas (Dennis 1996; de Vreede, *et al*. 2003; Robert *et al*. 2008). Therefore, idea integration is a key process for enhancing EBS productivity that should be of interest to EBS designers and leaders. Some empirical studies of EBSs have accounted for idea integration in the measurement of group productivity (de Vreede 2000; 2010), and have implemented mechanisms such as Relay methods, for improving idea integration. In Relay method, individuals in the group are organized into subgroups and are engaged in the brainstorming process in a sequential form, that is subgroups are instructed to start the ideation process where the previous subgroups ended (de Vreede 2000; 2010).

Integration is a critical pattern for knowledge creation by which dimensions of more than one individual's ideas are combined to create new and more integratively complex ideas (Okhuysen & Eisenhardt 2002). Integration is, in fact, the combination of explicit knowledge items (Nonaka 1994; Patanayuki *et al.* 2006), and idea integration occurs when individuals consider some or all dimensions of others' ideas (recognition) and create conceptual connections among different dimensions (integration) (Gruenfeld & Hollingshead 1993). While creating conceptual connections among different ideas requires relatively the same level of creativeness as sole idea generation, attending to others' ideas represents an additional process necessary for

achieving idea integration. Likewise, when contrasted to idea sharing, the supplementary requirement for idea integration is individuals' attention to the ideas shared by others (Dennis 1996).

If the generated and shared ideas are not attended to, processed, integrated and used by the recipients, idea sharing will not provide any benefit to the organization's success (Grant 1996b; Zhang & Watts 2008). Extant empirical studies on idea integration have indicated that integration does not occur automatically, individuals must be able and motivated to integrate ideas (Santanen *et al*. 2004; Homan *et al.* 2007). As such our attention-based theory posits that in addition to being concerned with the quantity and quality of ideas generated during the brainstorming process (Dean *et al*. 2006; Reinig *et al.* 2007), researchers, IS designers, group designers, and facilitators should be concerned with the rate and quality of idea integration during the brainstorming process. Since many organizations are adopting online collaborative knowledge creation platforms (McAfee 2006), the theory developed here focuses on computer-mediated or electronic brainstorming. As a result, the IS user interface becomes central to facilitating idea integration and thus to enhancing group brainstorming productivity.

Idea Integration: Definition

Idea integration occurs within groups where ideas are combined by individuals. In IS studies, idea integration or elaboration has been posited as complementary to idea generation. In EBSs for instance, task-relevant contributions are either task-relevant ideas or elaboration on previous ideas. The concept of an idea has been defined as a verb-object combination in prior IS research studies (de Vreede *et al*. 2000). Some verb-object combinations, however, may represent ethical statements such as: "I agree with solution A" (Simon 1976). Building upon the prior research, therefore, we define an *idea* as a basic element of thought represent by verb-

object combinations and consist of at least one testable proposition (Simon 1976; de Vreede *et al*. 2000;). A statement is still considered an idea if it is a mixture of ethical statements and testable propositions. For example: *"I think some sort of tarp would be useful for shade and shelter"*, is an idea exchanged during a desert survival brainstorming session. However, if the shared information primarily consists of ethical or imperative statements like *"I prefer solution A"* or *"I believe we should adopt solution B"*, or like the example from the desert survival brainstorming: *"We have to stick together though"*, it is not considered an idea, if it does not contribute substantial content. Similarly, if the shared information is a definition or description of an object, event or a process that does not include individual's perspective on it and does not provide any indication of relevance to the topic discussed in the group, it is not considered an idea (Baker-Brown *et al.* 1992). An example of such a descriptive statement from the desert survival brainstorming session is: "*Well we are 65 miles off course and we know we are in and S - SW of the mining camp"*. So, effectively, we exclude two forms of verb-object combination, namely, purely descriptive and ethical statements, from our definition of an idea.

Idea integration, also referred to as combination or synthesis, is considered the most fruitful phase of the creative process (Osborn 1953). The current study maintains that idea integration is a critical process that has dimensions of both convergent and divergent thinking (Guilford 1956). Integration involves divergent thinking in that individuals consider different perspectives of the shared ideas; integration involves convergent thinking in that individuals must create connections among different dimensions of the various ideas to frame an integrated idea.

Table 1: Studies of Idea- and Knowledge-Integration			
Study	**Dependent Variable**	**Definition of the Construct**	**Approach**
Dennis (1996)	Information use	Use of unique information owned by others	Information recall-exchange-processing and use theory
Vreede, *et al.* (2000; 2010)	Elaboration	A task relevant reference to a previously submitted unique idea. So, e.g., a comment	Decathlon (parallel) vs. relay (serial) sub-groups
Okhuysen & Eisenhardt (2002)	Knowledge Integration	Use of unique knowledge pieces owned by others	Use of formal interventions for directing and switching attentions
Sussman & Siegal (2003)	Information adoption	A manifestation of knowledge internalization in organizational advice-receiving context	Adoption and information influence theories
Homan *et al.* (2007)	Information elaboration	Elaboration on task-relevant information and perspectives	Pro-diversity as integration enabler
Robert *et al.* (2008)	Knowledge integration	Making reference to other's ideas	Social capital theory

In the IS literature, idea integration has been conceptualized as the explicit reference to partners' ideas in forms of comments, and has been categorized as a measure of effectiveness or a measure of communication within the category of effectiveness measures (Fjermestad & Hiltz 1999, 2001). EBS studies have referred to the task-relevant reference to previously generated ideas as elaboration and have included the concept in productivity measurement (de Vreede *et al.* 2000, 2010). Moreover, an elaboration coefficient has been suggested to represent the extent to which discussion is taking place during electronic meetings. Other research studies have identified knowledge integration as the outcome of elaboration, which is described by information exchange and information processing at the individual level, followed by integration at the group level (Homan *et al.* 2007, see Table 1). Information adoption and use are also two very closely related constructs used in IS research studies because it involves attending and appropriating the task-relevant shared information for performing the task (Dennis 1996; Ferran & Watts 2008; Sussman & Siegal, 2003).

The current paper uses the term idea integration to explicitly emphasize the integration aspect of information adoption and use and to highlight the level of analysis (within groups). We suggest that idea integration is a process that precedes the creation of combinative ideas but does not guarantee the creation of unique ideas. Different levels of idea integration thus contribute to brainstorming productivity in different ways. The basic level of integration, indicated by a statement such as "I agree," for instance, is believed to be important in giving meaning and value to the idea that is being referred to (de Vreede, *et al.* 2000; 2010). To distinguish between different levels of idea integration ranging from mere reference to others' ideas to completely integrating others' ideas with those of their own, this paper applies the well-studied concept of *integrative complexity* in social psychology (Baker-Brown *et al.* 1992; Suedfeld *et al.*1992).

Integrative Complexity

Integrative complexity is a measure of the individual tendency to consider decision-relevant information from more than one dimension (Suedfeld *et al.* 1992). Within groups integration involves the generation of new conceptual relations among different perspectives (Gruenfeld & Hollingshead 1993). Integrative complexity has been identified by two phases of differentiation and integration. Differentiation is the perception of different aspects of a subject, and integration is the recognition of connections among those aspects (Suedfeld *et al*. 1992). Idea integration, in the current study, is defined as an activity that leads to creation of integratively-complex ideas. Idea integration occurs when an individual refers to the ideas proposed by other individuals (de Vreede *et al.* 2003; Robert *et al*. 2008) and creates the conceptual connection among those ideas and his or her own ideas (Gruenfeld & Hollingshead 1993; Santanen *et al*. 2004). Reference may be made to an idea as a whole or to some *dimensions* of the ideas. Even though *dimensions* are considered building blocks in the study of integrative complexity (Suedfeld *et al.* 1992), we are not aware of previous research studies that have explicitly defined them. An i*dea dimension* is defined here as "a unique testable proposition." Thus, the shared information is called a multi-dimensional idea if it includes more than one unique testable proposition, an example from the desert survival would be *"Some sort of outer shell jacket that is water proof, can be used to collect water if it rains, covers body at night."*

It is important to distinguish between the "state" and the "trait" of integrative complexity. Defining integrative complexity as a cognitive or information processing style (Harvey *et al.* 1961), some researchers refer to it as a trait while many other researchers consider it as having dimensions of both trait and state (Streufert & Swezey, 1986). Some studies have also referred to integrative complexity as a changeable trait. Trait complexity is the one that is less likely to change while state complexity is prone to environmental mediators (Suedfeld *et al.* 1992).

It is not certain, however, whether higher integrative complexity leads to better quality outcomes in general tasks. However, since brainstorming involves creative thinking, higher integrative complexity is expected to lead to better ideas. Gruenfeld and Hollingshead (1993) have conjectured on the correlation between integrative complexity and task performance based on the task type in which the performance of conceptual tasks and intellective tasks are positively correlated with integrative complexity. Further, integrative complexity and task performance will be much more highly correlated for a non-decomposable task than for a decomposable one. Since the current paper is concerned with brainstorming, which is a creative and non-decomposable task, we presume that idea integration will contribute to the quality of the brainstorming outcomes.

In empirical studies of group brainstorming, idea integration has been shown to improve productivity or outcome quality (Okhuysen & Eisenhardt 2002; Patnayakuni *et al*. 2006; Robert *et al.* 2008). In the studies of elaboration in EBSs, for instance, Relay groups in which sub-groups work in a serial manner were found to be more productive than Decathlon groups in which subgroups worked in a parallel manner (de Vreede *et al*. 2000; 2010). The productivity gain was mainly associated with higher elaboration rather than with an increase in the number of unique ideas (there was a slight but not statistically significant improvement in the number of unique ideas). The extent of elaboration has been measured with a collaboration coefficient calculated as the number of task-relevant elaborations over the number of task relevant communications minus one (de Vreede *et al.* 2000; 2010). Whether or not there is a correlation between elaboration coefficient and the quality of ideas, however, is still an open question.

We define idea integration based on integrative complexity for several reasons. First the definition allows for flexibility in the operationalization of idea integration within groups. With

few exceptions (de Vreede 2000, 2010) empirical studies have focused mainly on the quantity of integration as measured by the number of references made by individuals to ideas of others (Homan *et al*. 2007; Robert *et al*. 2008). However, since different combinations of the same factual information (testable propositions) may generate different combinative outcomes (Okhuysen & Eisenhardt 2002), measuring levels and quality of idea integration is important in examining the value created by idea integration (de Vreede, *et al*. 2000). The level of idea integration within groups also influences the value of knowledge integration at the organizational level. The current paper's differentiation among integration levels or degrees enables stronger theory development and more precise empirical testing, which can better link idea integration within groups to the creation of organizational knowledge-based capabilities (Santanen *et al.* 2004). Based on this definition of idea integration, the next section proceeds to describe our proposed attention-based theory.

Background

The proposed attention-based view here is based on Simon's logic of attention being a scarce resource (Simon 1947; March & Simon, 1958). The assumption is that attention is one essential element for initiating idea integration in groups and that in electronic groups IS user interface may be used to manage the underpinning attentional processes of idea integration. Like previous research studies of attention scarcity in organizations, the desired process here for individuals is to integrate ideas within groups. The desired action or process, in attention based view of the firm, for instance, is referred to as a *move* (Ocasio 1997). A *move* is defined as an intentional processes shaped by individuals. Desired moves can be nurtured through regulating forces that channel individuals' attention towards them. Regulating forces for channeling individuals' attention can be implemented through organizational rules that value and motivate

the desired moves. Similarly, idea integration, as the desired move in our study, must be valued and be motivated; and our proposed theory suggests that valuing and motivating idea integration can be realized by use of IT interface features for managing integration's underpinning attentional processes.

The attention-based theory developed in this paper is also based on the Cognitive Network Model (CNM) of creativity and ability-motivation framework (Santanen *et al.* 2004; Thoemmes & Conway 2007). CNM has been viewed as a foundation for understanding causality in creativity contexts. We regard idea integration as a specific form of creativity that relies on perceiving different dimensions of the shared ideas, retrieving relevant concepts from long term memory and creating novel combinations among perceived and activated concepts (Santanen *et al*. 2004). Further, for idea integration to occur individuals must be *able* and *motivated* to do so (de Vreede *et al*. 2003). In the following sections, the developed theory is positioned with respect to the Cognitive Network Model of creativity and ability-motivation framework.

Cognitive Network Model of Creativity

The Cognitive Network Model (CNM) of creativity explains causality in creativity based on principles of long term memory retrieval and activation in working memory. Models of memory suggest that for information to become available to the working memory it should be retrieved and activated by probing long term memory with cues. For instance, according to the two theories of Adaptive Control of Thought (ACT) and Search of Associative Memory (SAM) (Anderson 1983, 2005; Anderson & Lebiere 1998, Raaijmakers & Shiffrin 1981), memory traces become more or less active as a function of cues in the context. Since CNM has developed a causal relationship among the extent, frequency and diversity of the cues presented to individuals and outcomes' creativity level, it has been used widely a basis for designing collaboration

processes with predictable effects (Kolfschoten *et al.* 2010). Similar research studies also use CNM to design effective facilitation mechanisms that warrant more creative group outcomes (Santanen *et al*. 2004).

CNM thus posits that creativity initiates when individuals search in long-term memory's knowledge maps using cues available to them or made available to them through external stimuli. Relevant frames are then transferred from long term memory to working memory and creativity happens when links among originally distant frames are created (Briggs 2006; Santanen *et al*. 2004).

In additional to automatic aspects of search, retrieval, and activation, idea integration requires individuals' mindfulness (Driver & Streufert 1969; Levinthal & Rerup 2006; Santanen, *et al.* 2004). Mindfulness empowers associative thinking (Osborn 1953; Potter & Balthazard 2004) by enhancing recognition of different dimensions of the shared ideas. Recognition of different dimensions invokes search in one's memory using clues contained in those ideas and retrieval of related concepts. Mindfulness also empowers integration by facilitating creating connections among the retrieved concepts (Gruenfeld & Hollingshead 1993).

Thus, when certain ideas are presented to individuals and are attended to, memory traces of related concepts become more active and therefore the connections among those ideas are more likely to be discovered. This happens because in associative memory the frames that are initially retrieved and activated instigate what is activated next through spreading activation (Santanen *et al.* 2004; Anderson 2005). To the extent that the environment encourages complex behavior and motivates idea integration, it then becomes likely that those connections are articulated as combinative ideas by individuals in a brainstorming process.

Since each idea that an individual attends to provides a potential set of cues that can be used for the individual's memory search process (Potter & Balthazard 2004), the number of potential cues and as a result the level of activation increases as the number of visible ideas increases. However, similar to what happens in many Web 2.0 knowledge-sharing applications (e.g., *Yahoo Answers* and *Mail.ru*) an abundance of information can also divert an individual's scarce resource of attention and overwhelm individual's cognitive resources (March & Simon 1958; Potter & Balthazard 2004; Santanen *et al.* 2004). One method for overcoming the attention diversion is to use the IS user interface to optimally manage individuals' attention.

Individual's Ability and Motivation

Idea integration as an outcome of integrative complexity occurs when individuals are able and motivated to combine ideas with those others. Idea integration relates to the extant constructs of elaboration and integrative complexity (Gruenfeld & Hollingshead 1993; de Vreede *et al.* 2000). Complex thinking is not only a matter of ability, but also a matter of motivation (Thoemmes & Conway 2007). Complexity research proposes that the organizational context can foster different levels of complexity. Situational conditions such as environments rewarding complexity are thought to influence the level of state complexity (Homan *et al.* 2007; Suedfeld *et al.*1992). State complexity is a changeable aspect of integrative complexity and most of the previous literature on integrative complexity research has dealt with state complexity (Gruenfeld & Hollingshead 1993). Therefore, integrative complexity, as a malleable individual information processing style can be enhanced via IS user interface (Suedfeld *et al.* 1992).

Integrative complexity consists of the two phases of differentiation and integration. Differentiation, which is the perception of different dimensions of the shared idea, requires processing of the information contained in those ideas. For processing information contained in

the shared ideas, individuals may take two different routes (Dennis 1996): (1) central route is when individuals actively assess the information contained in the ideas they are exposed to; and (2) peripheral route is when individuals' assessment of the information contained in the ideas they are exposed to is mainly influenced by the preferences of others. When individuals take central route thus their ability for perceiving and integrating different dimensions may be facilitated by effective presentation of ideas via the user interface. When individuals take peripheral route, individuals' information processing may be fostered by effective presentation of preferences of others via the user interface. Preference of others, for instance, may be used to prioritize ideas that are displayed the screen. When individuals take peripheral route, therefore, prioritization influences an individual's evaluation of the shared ideas and thus their tendency to use those ideas in integration.

To foster the integration of perceived different dimensions IS interface can foster individuals' disposition towards and motivation for integrating the differentiated dimensions. Motivation is indispensable for integration. Individuals should perceive value in integration so they become motivated in taking the necessary steps for idea integration. In general, idea contribution in electronic brainstorming occurs when individuals are motivated to generate and share ideas, review the ideas shared by others, generate follow-up ideas and evaluate ideas shared by others (Wasko & Faraj 2005). Idea integration occurs when individuals review and process ideas shared by others and refer to them and use them when creating new ideas (Dennis 1996; de Vreede *et al*. 2003; Robert *et al*. 2008). Substantial research literature on idea sharing and the extant empirical studies on idea integration provide suggestions on how to motivate information sharing or integration in the groups. Some research studies (e.g., de Vreede *et al*.

Figure 1: Theoretical Framework
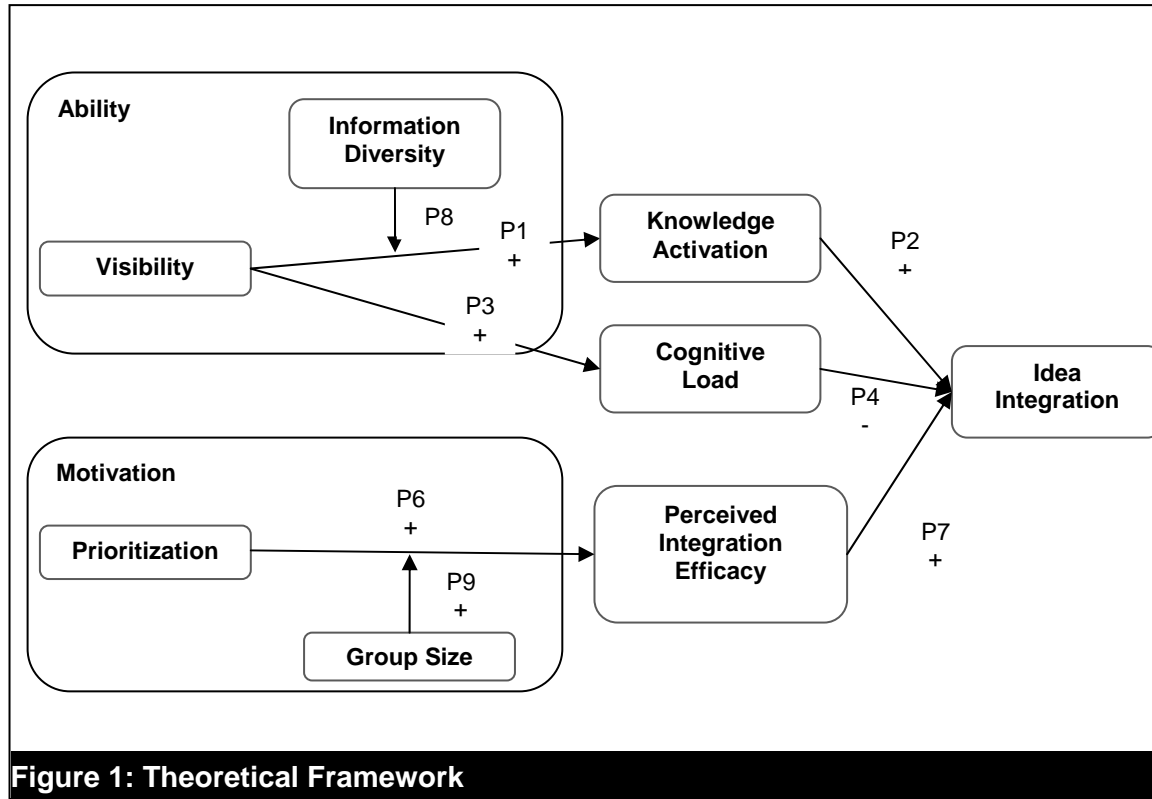
2000; 2010) used Relay mode to promote idea elaboration. In Relay mode subgroups follow the brainstorming when previous subgroups finished it. Homan *et al*. (2007), in the lab experiments, promoted pro-diversity beliefs to persuade more information elaboration, which they suggest leads to information integration.

We are unaware of previous research studies that have explored the potential of user interface features to augment state complexity and advance complex thinking but previous research has used display variations when implementing different forms of social comparison (Shepherd *et al.* 1996). To augment state complexity motivation for attending to the shared ideas, any signal of usefulness, legitimacy or relevance of the ideas could be effective (Sussman & Siegal 2003). And since the amount of attention allocated to ideas of others is consistent with the

cognitive effort allocated to finding associations among them, higher levels of attention are expected to lead to actuating more idea integration (Simon 1947).

The theory focuses on state complexity (Suedfeld *et al.* 1992) and examines features of the user interface that influence an individual's ability and motivation for state integrative complexity through managing underlying attentional processes.

Attention-Based View of User Interface Effect on Idea Integration

The crux of our attention-based view is that attending to others' ideas is essential for idea integration and that attention can be managed through user interface. Building on the Cognitive Network Model of creativity and the ability-motivation framework, the current attention-based theory utilizes *visibility* and *prioritization* of ideas as two key mechanisms by which attention to ideas is directed and reinforced. Prior empirical studies of idea integration use interventions for directing and switching individuals' attention to enhance elaboration and idea integration (Okhuysen & Eisenhardt 2002; de Vreede *et al*. 2003). To advance ability and motivation for idea integration, our proposed theory uses visibility and prioritization as two interface-based interventions for channeling brainstormers' attentions (Figure 1). Since individuals have been shown to be able to focus only on a limited number of ideas at any given time (Simon 1947), we suggest that only a portion of a larger idea pool will receive effective attention. Therefore ideas generated and sharing during brainstorming compete with each other to receive the brainstormer's attention (Hansen & Haas 2001). For distributing attention among the ideas, chronological order, or rank-based order (order based on collective evaluation of the ideas by the group) are two commonly used methods to organize idea pool on the screen.

Our definition of idea visibility is consistent with that of availability and saliency of issues and answers in the existing attention-based view research studies (Simon 1947; Ocasio

1997). Prioritization is also a manifestation of selectiveness by which preferences of individuals are represented through the rating of ideas. Prioritization is proposed to stimulate more idea integration when it is the desirable action. Since individuals are selective in the ideas they attend to and since the actions individuals perform -- generation, sharing and integration of ideas -- depends on how their attention is channeled, the current attention-based theory posits that visibility and prioritization are key drivers of the integrative behavior in EBS (Hollingshead 1996; Ocasio 1997).

Since managing attentional processes is the core of our proposed theory, the theory partly addresses the problem of process losses in brainstorming such as cognitive dispersion (Pinnsoneault *et al.* 1999). Process losses have been shown to be as much likely to happen in EBS as they are in verbal brainstorming (Fjermestad & Hiltz 2001). The next section provides the propositions derived from our theory development.

Propositions of the Attention-based View of Idea Integration and User Interface Design

The proposed attention-based view of idea integration posits that individuals must attend to the ideas shared by others so as to discover new perspectives. Based on Cognitive Network Model of creativity, attention enables creating connections among different dimensions, which is realized through creating associations among their correspondent frames in the working memory (Osborn 1953; Santanen *et al*. 2004). Taking the ability-motivation framework perspective, for directing individuals' attention in a group context and thus enhancing their ability for idea integration, relative visibility or salience of ideas becomes important (Dennis 1996; Santanen *et al*. 2004). In general, saliency of any chosen mechanism is important for attracting brain-stormers' attention and thus for its effectiveness. An empirical study of EBS, for example, used facilitation to increase saliency of the social comparison technique so as to hamper social loafing

(Shepherd *et al*. 1996). As a result, highly salient social comparison technique lead to a 63% productivity gain compared to only a 22% gain for low salience social comparison.

Based on CNM, however, an excessive number of stimuli presented to individuals caused by high saliency or over-exposure to ideas of others may impede creativity. Thus idea integration, as a creative process, can be enhanced by selective attention to a limited number of ideas at each time. For directing individuals' selective attention, criteria are required for organizing ideas on the screen. If the criteria are a proxy of idea usefulness, then the motivation for idea integration is also enhanced (Thoemmos & Conway 2007). Indeed, any mechanism for inferring usefulness of the shared ideas will augment individual tendency for using them and thus augments motivation (Sussman & Siegal, 2003). Visibility and prioritization are explained in following sub-sections.

Visibility

Visibility of ideas in our theory can be viewed as an interface-based instance of the construct *stimuli quantity per time unit* in the Cognitive Network Model of creativity (Santanen *et al.* 2004). Visibility defines the extent of information that is presented on the screen at any given time. Visibility of the ideas through the user interface facilitates members' exposure to the different dimensions of the shared ideas and thus stimulates activation of associated frames in working memory. According to CNM (Santanen *et al*. 2004), visibility of ideas stimulates search for and retrieval of relevant concepts and thus enables creating connections among those related concepts. Idea visibility is therefore, a predictor of the idea being used in an integration activity when brainstorming is taking place. With the shift from information scarcity to information richness in modern organizations, visibility of ideas becomes even more important (Hansen &

Haas 2001). Visibility identifies the extent to which ideas generated by members of the group are salient to other members.

While the visibility construct, in the current paper, is examined in the context of IS user interface design, it is independent of any particular type of information system technology (Briggs 2006). Visibility is defined by the portion of the idea pool that is visible on the screen at any given time without extra effort (e.g., clicking) and it is posited that visibility plunges as the effort for viewing the ideas increases. Visibility refers to the number of ideas that are placed on the screen and are visible without requiring any extra effort. By visibility, individuals' attention is channeled through the user interface where ideas are presented to them and the extent to which the ideas are exposed to the viewers depends on their position on the screen. We suggest that visibility of the idea affects the focus of attention, which in turn influences the extent to which relevant concepts are activated in working memory. This activation in working memory based on the stimuli available in visible or salient ideas is discussed next.

According to the Cognitive Network Model of creativity, the influence of visibility on idea integration is described by the mediating effect of retrieving relevant concepts from long-term memory and activation of those concepts in associative memory. Knowledge activation is the outcome of search in long term memory which makes idea integration possible. Increased visibility leads to an increased number of cues made available by visible ideas which facilitates enhanced knowledge activation in memory. Activation of more items in memory increases the possibility of individuals' discovering and articulating connections among different ideas' dimensions. As pieces of information in visible ideas are more likely to be used as cues to probe an individual's memory, the memory search process is likely to return results that are connected to these ideas; and therefore the visible ideas are more likely to be referred to in the integration

process. As such, this paper posits that the overall visibility of the items influences the level of activation of the relevant concepts and thus idea integration (Grownski & Bodenhausen 2005):

> ***Proposition 1****: Knowledge activation is positively associated with idea visibility.*
>
> ***Proposition 2****: Idea integration is positively associated with knowledge integration.*

We maintain that because of the highly asymmetric nature of the knowledge repositories of individuals, exposure to other individuals' ideas is beneficial. It is important to note that even attending to *ad-hoc* categories and cues provided by others' ideas is beneficial when a problem at hand is unstructured and requires diverse information, which is presumed to be the case in brainstorming. The analysis presented here is based on assumptions that individuals possess heterogeneous knowledge on the subject being discussed and that the subject is beyond any single individual's capability for solving it (de Vreede *et al.* 2003), and therefore integration of individuals' ideas is desirable. CNM, however, posits that high levels of stimuli presented to individuals also causes cognitive load (Santanen *et al.* 2004). Similar experimental research studies also found that attending to input from others is detrimental to productivity in brainstorming (Potter & Balthazard 2004).

When visibility increases, for example, cognitive overload and interference has been shown to diminish individuals' abilities for discovering associations among activated items and thus their ability for idea integration (Potter & Balthazard 2004; Santanen *et al.* 2004; van Merrienboer & Sweller 2005). Also since the processed ideas and their relevant activated items reside in an intermediate short-term memory that has limited capacity (i.e., memory span), only a few items can be active in memory at the same time. Memory span is defined by the number of elements that one can immediately repeat back; and the general view is that memory has room for about seven elements (Anderson 2005) thus knowledge activation above some threshold may

not be possible and thus generate no benefit in terms of idea integration. Particularly, CNM have noted the external stimuli contribute to the idea generation performance only when delivered at a rate that does not overwhelm the brainstormers' attention and cognitive ability (Santanen *et al.* 2004). Considering limited memory span and cognitive interference, the theory proposed here posits that:

Proposition 3: Cognitive load is positively associated with idea visibility.

Proposition 4: Idea integration is negatively associated with cognitive load.

Propositions 1 and 4 imply that idea integration is curvilinearly associated with visibility through the mediating effect of knowledge activation and cognitive load. The curvilinear nature of this relationship captures cognitive load caused by excessive exposure to inputs from others because reading, understanding, and following the inputs of others will cause cognitive dispersion (Pinsonneault *et al.* 1999; Potter & Balthazard 2004). 2004). The curvilinearity rises from the tradeoff between exposure to ideas of others and attending to those ideas and focusing and reflecting on the own background knowledge maps and on creating connections among activated frames (Santanen *et al*. 2004).

Thus, exposure to ideas of others can at times be beneficial and at times detrimental depending on its extent (Potter & Balthazard 2004). While for low levels of visibility, the capacity of individuals for retrieving frames from a cognitive map and for creating a connection, is not fully utilized, high levels of visibility will cause issues with the capacity limits of working memory which is the locus for manipulating activated concepts and for discovering new combinations (Santanen *et al*. 2004). Therefore our theory posits:

This curvilinear effect is consistent with the fact that excessive mindfulness will incur costs in terms of the scarce resource of attention (Levinthal & Rerup, 2006). If high proportion of

ideas becomes visible to the group, they may overwhelm brainstormers, and cause distraction or production blocking as well (Briggs 2006; de Vreede *et al.* 2000). This tension between combinative creativity (combining already existing ideas) and original creativity (creating new ideas) motivates the current paper's quest for finding an optimal or moderate range of exposure to ideas of others. The next section elaborates on prioritization for motivating idea integration.

Prioritization

The cognitive network model of creativity posits that spreading activation as described in the previous section has automatic and conscious components (Santanen *et al.* 2004). The automatic part occurs without intention and the other requires intention and conscious processing. While visibility in our model has bearings on exposure as an instrument for directing the unconscious part of activation, prioritization appertains to the conscious aspect of spreading activation.

In addition to attending to the shared ideas, the conscious aspect of idea integration requires valuing the shared ideas and valuing idea integration. Idea integration in MacGrath's (1984) typology of tasks may be categorized as an intellectual and a cooperative task. For idea integration to occur, it is necessary that individuals in the groups positively evaluate the ideas shared by others (Borgatti & Cross 2003; Sussman & Siegal 2003). Since individuals engage in social interaction based on the expectation of some type of rewards, individuals should perceive value in idea integration so that they process shared ideas and then engage in integrating them with their own ideas (Blau 1964; Siemsen *et al*. 2007).

Prioritization in the current paper is defined by using a criterion or a set of criteria for ordering ideas on the screen. The most commonly used prioritization method in verbal brainstorming is collective evaluation by the group. Prioritization based on the collective

evaluation of the group is one of the few feasible real-time methods of prioritization in EBS because during brainstorming accurate evaluation of the ideas based on organizational goals (Litchfield 2008) cannot be accomplished. When there is no prioritization, ideas may be displayed on the screen based on their chronological order or ideas may be shuffled on the screen randomly.

The criterion for prioritization, therefore, can be individuals' preferences regarding the shared ideas as indicated through a rating scale. Using this method, ideas are prioritized if they are ordered based on the collective ratings by the group. Prioritization based on collective rating is analogous to the use of citation numbers in academic research paper databases to infer the influence of research papers. Many state of the art online discussion platforms use similar mechanisms, such as star rating systems (used in *Amazon.com* reviews or in *Yahoo Answers*). Similarly, file, music, and video sharing and many online news papers and news aggregators provide individuals with a mechanism to evaluate items and then use the aggregated ratings as a criterion to determine visibility of the items. In EBS, when the number of visible ideas on the screen is limited, lower-ranked ideas will be placed down the list. As a result, the probability of an idea being exposed to individuals' attention is high for high-priority and low low-priority ideas.

To capture an individual's evaluation of others' ideas and an individual's proclivity to idea integration, taking ability-motivation framework, this paper introduces the *perceived integration efficacy* construct. Perceived integration efficacy is defined to encompass (1) individuals' evaluation of others' ideas (perceived value of information); and (2) perception of the gains from idea integration (perceived value of integration). We posit that the criterion for ordering ideas influences an individual's perceived integration efficacy. For instance, if the ideas

are prioritized based on the group's collective evaluation, individuals attribute more value to the ideas being displayed. Moreover, prioritization reduces uncertainty in individual decision making for idea integration. It is thus submitted that individual perception of the integration efficacy is higher when ideas are prioritized by the group, and this logic leads to the following proposition:

> ***Proposition 5:*** *Prioritization leads to the formation of higher perceived integration efficacy.*

In summary based on the ability-motivation framework, *Proposition 6,* states that prioritization of ideas on the screen will lead to individual's easy access to the preference of others and consequently influences their motivation for idea integration, which is represented through perceived integration efficacy in our theory.

Prioritization provides a signal that may or may not be sufficiently close to the actual value of the ideas. The discussion of how accurately a particular prioritization method represents the ideas' true values or whether prioritization criteria are moderately or significantly discounted by individuals selecting ideas for integration is beyond the scope of the current paper. The theory constructed here is based on the ability-motivation framework, which posits that the presence of a prioritization mechanism will enhance the total amount of attention allocated to the shared ideas and boost the extent to which they are reviewed and considered.

Perceived Integration Efficacy

Since individuals differ in the extent to which they value diversity, prioritization provides a feasible (even though imperfect) mechanism for promoting individual's tendency to integrate by boosting their perceived integration efficacy (Petty & Cacioppo 1986). In our theory, perceived integration efficacy is defined by two sub-constructs. The first sub-construct relates to the belief of an individual regarding the value of the shared ideas (*perceived value of ideas*),

which is similar to *information usefulness* (Sussman & Siegal 2003) but is more general than *perceived information credibility* (Dennis 1996), which have been used in prior research studies of information adoption and use. The second sub-construct relates to the *perceived value of idea integration*, i.e., an individual's belief regarding the extent to which integration contributes to the value of the ideas generated by the individual, which is a new concept introduced in this paper.

According to ability-motivation framework, we posit that, higher levels of *perceived value of idea integration* will elicit more idea integration, because individuals' actions are generally based upon their beliefs of the consequences of those actions (Simon 1976). *Perceived value of ideas*, also, has been proven to augment idea use. For instance, the extant literature on information adoption and use suggests that perceived usefulness or credibility or value of the knowledge item will trigger its use and adoption (Sussman & Siegal, 2003). The current paper, thus, posits that individuals are more likely to integrate ideas when perceived integration efficacy is high:

> **Proposition 6**: *Idea integration is positively associated with perceived integration efficacy.*

Perceived integrative efficacy is a composite construct that includes perceived value of ideas and perceived value of idea integration as formative sub-constructs (Edwards & Bagozzi, 2000).. Each sub-construct may be represented by a set of reflective items. The next section considers two important moderators of the current paper's framework.

Moderators

The substantial literature on brainstorming and electronic brainstorming has identified a variety of factors that influence the quality of the brainstorming process. Some examples are group nominal and logical size, group composition, group leadership, members' engagement,

facilitation and facilitation saliency, time structuring and evaluation mechanisms (Valacich *et al.* 1995; Fjermestad & Hiltz 2001; de Vreede *et al*. 2003; Santanen *et al*. 2004;; Zhou & Shalley, 2007). It is naturally expected that the relationship between IS user interface and idea integration will be impacted by some of these elements. CNM, for instance, posits that diversity of stimuli presented to individuals increases the associative distance among the activated frames in the working memory and thus augments creativity. Since diversity of stimuli presented to individuals in EBS is represented by the extent of information diversity of visible ideas, information diversity is proposed to be a key moderator in our model. Also, group size which has proven to be a critical moderator in the study of group brainstorming (Gallupe *et al.* 1992, Dennis & Wixom 2001) is proposed to influence prioritization effectiveness. The moderating effect of information diversity and group size on the association between idea integration and prioritization respectively, is described in the following sub-sections.

Information diversity

As ideas that are attended to become more diverse, the potential for integration increases because information diversity will by itself stimulate integration (van Knippenberg *et al*. 2004). Information diversity here represents variety of the ideas or more precisely the variety of information contained in the ideas generated and shared by individuals within the group. This type of diversity has been linked to higher levels of creativity and cognitive complexity (Harrison & Klein 2007). Information diversity results in diversity of stimuli which draws higher levels of disparity among the concepts that are retrieved from long term memory (Santanen *et al*. 2004). The higher the disparity among activated concepts in working memory, the higher is the potential for knowledge integration. If knowledge that is possessed and shared by individuals is homogenous or identical, there will be no gain from integration (Grant 1996a). Since integration

occurs when different perspectives are combined, *ceteris paribus*, a highly diverse set of visible ideas is more likely to stimulate generation of integrative ideas than a less diverse set of visible ideas. A diverse set of visible ideas contains a diverse set of cues, which may be used for probing memory and thus facilitates retrieval and activation of associatively distant concepts (Santanen *et al*. 2004). Diversity of ideas, therefore, increases the extent to which visibility influences knowledge activation and idea integration. Thus, the gains from controlled visibility should increase with higher diversity of the idea pool. As such, the current paper suggests that diversity moderates the relationship between visibility and knowledge activation:

> ***Proposition 7****: Information diversity moderates the relationship between visibility and knowledge activation, such that higher levels of information diversity are associated with stronger associations between visibility and knowledge activation.*

While visibility helps with directing individuals' attention, and facilitates activation of the relevant concepts, information diversity boosts the disparity among the activated concepts. Moreover diverse information stimulates original ideas through expanding a group's logical size (Valacich *et al*. 1995). It is important to note that empirical research studies have found that the mere presence of diverse information may not provide any benefits for generation, sharing or integration of ideas (Philips *et al*. 2004; Wooley *et al.* 2008), but individuals must be motivated to do so. To address the motivation issue, the proposed theory includes both visibility as an enabling force and prioritization as a motivational force for enhancing idea integration.

Group Size

Similar to many theoretical and empirical research studies of electronic brainstorming (Dennis & Valacich 1999; Dennis & Wixom 2001), group size is considered to be an important moderator of the relationships proposed in the current paper. Particularly, the size of the group is posited to moderate the association between prioritization and perceived integration efficacy.

Prioritization here is defined as a mechanism for signaling value or usefulness of ideas (Sussman & Siegal 2003) which is a method for ordering ideas on the screen as well. In larger groups, for example, more people are available for evaluating an idea (Gallupe *et al*. 1992) therefore prioritization based on the collective evaluation of the idea will be more credible in larger groups than it is in smaller groups. Assuming that individuals take the peripheral route for information processing (Petty & Cacioppo 1986) the extent to which the preferences of others is discounted is expect to be less when the group is larger. Thus, there will be more gain in terms of the perceived integration efficacy. Moreover, since in general the idea pool is expected to be larger for larger groups, prioritization has more of an intense effect on ordering ideas in larger groups (wider range of positions on the list of ideas) and has less of an effect in smaller groups. As such, group size is an important moderator in the model:

> ***Proposition 8:*** *Group size moderates the relationship between prioritization and perceived integration efficacy such that prioritization is associated more strongly with perceived integration efficacy in larger groups than in smaller groups.*

Now that the discussion of the proposed theory's constructs and moderators has concluded, a brief guideline for conducting empirical examination of this theory follows.

Experimental Examinations of the Theory

The proposed theory could be examined in both laboratory and field settings. In laboratory experiments, for instance, hypotheses derived from the propositions of the theory may be tested in an experiment with factorial design: three (Visibility low, medium, and high) by two (prioritization, no prioritization) by two (small groups, large group). Participants in the lab experiments would be invited to brainstorm electronically within groups using an experimental software system that allows for manipulations of visibility and prioritization. The task can be an open idea generation task.

Visibility could be manipulated by varying the number of ideas that are displayed on the screen, and prioritization could be implemented as star ratings provided by the brainstormers. To motivate active participation during the experiment, each participant could be assigned a score that increases for activities contributing to the group discussion, including posting an idea, rating other participants' ideas and referring to other participants' ideas. The score of the individual then could be used to determine his or her chances of winning a prize.

The software would generate experimental transcripts to be used for measuring idea integration and information diversity. External coders blind to the experimental conditions should be recruited and trained to analyze the transcripts of the experimental sessions, coding each statement and as idea generation or integration (de Vreede *et al.* 2000; Baker-Brown *et al.* 1992). Idea generation measurement could be based on the vast IS literature (e.g., Reining *et al.* 2007). Idea integration measurement could be based on elaboration measure (de Vreede *et al.* 2000), we anticipate that a multi-level measure of idea integration based on elaboration and integrative complexity measures would best suit the context of the proposed theory (Baker-Brown et al. 1992; de Vreede *et al.* 2000).

Perceived integration efficacy should be measured by its two sub-constructs: (1) Perceived Value of Information and (2) Perceived Value of Idea Integration. Each sub-construct may be represented by a set of reflective items asked in self-report questionnaires. Perceived Value of Information, for instance, may be measured by items such as *I am not sure that all the ideas that others contributed had much value or I am convinced that all the ideas everyone posted was valuable* (Dennis 1996). Perceived Value of Idea Integration may be measured using items such as: *Combining my ideas with ideas posted by others created better ideas* or *I am not sure if using ideas posted by others has helped me generate better ideas.*

The theoretical construct of prioritization is expected to have distinct effects when examined in groups of small and large, with group variable being a categorical variable (Fjermestad & Hiltz 1999). Research literature has posited that dyads behave differently from large groups in many ways. In GSS experimental studies the smallest group has usually been groups of three.

Examination of the theory developed here may also be performed by collecting data from relevant resources available online (e.g., across different platforms such as *Yahoo answers*, *Facebook* discussion forums, twitter or similar applications. Empirical research may further examine whether manipulations derived from propositions of the proposed theory elicit different forms of effect when used sequential or parallel settings (de Vreede 2000; 2010; Fjermestad & Hiltz, 2001). Empirical studies may also aspire to test the propositions in settings where individuals use the system in several sessions in order to test for possible effects of adaptive structuration on user interface-idea integration relationship (e.g., Niederman *et al.* 2008).

Contributions

This section summarizes contributions of the current paper to four areas of scholarship:

(1) *Contributions to the electronic brainstorming literature*: the conceptualized link between user interface and idea integration which is built based on Cognitive Network Model of creativity (Santanen *et al*. 2004) provides the foundation for design of EBS with predictable levels of idea integration. Idea integration can lead to an increase in the number of combinative ideas and consequently to increased depth in the discussion. Idea integration can thus deepen the understanding within groups and curtail the number of redundant ideas (de Vreede *et al*. 2000; 2010). Too much idea integration, however, can limit the original creativity because of cognitive bias. Also, excessive elaboration may limit the boundary of the solution space, when individuals are biased towards certain directions of the solution space based on what they're exposed to and influenced by (de Vreede *et al*. 2000; 2010). Our theory of idea integration provides a basis for balancing original idea generation with idea integration. It also aspires to contribute to the discussion of productivity and effectiveness of EBS (de Vreede *et al*. 2003; 2010) by advancing idea integration as a key EBS productivity measure (Dennis & Valacich 1999).

(2) *Contributions to the IS literature on user interface design*: this study extends the use of interface attributes for achieving idea integration and constructs a theory that links IS user interface design to the underpinning of attentional processes for enabling and motivating idea integration (Dennis *et al*. 1996). The quest for finding a better fit between user interface features and the cognitive requirements of the idea integration provides a new pathway for research and practice on IS interface design. IS interface research has high potentials for supporting cognitively intensive tasks such as electronic brainstorming and the constructs here can inform user interface design to support it (Rao *et al*. 1992).

(3) *Implications for organizational knowledge integration and use*: building upon Simon's (1947) logic for attention as a scarce resource in organizations, the proposed theory links IS interface attributes to the creation of an organization's knowledge-based capabilities. Idea integration and elaboration (de Vreede *et al*. 2003) are important for ensuring the relevance of EBS to the creation of an organization's knowledge-based capabilities. This theory thus reinforces the role of IT for the creation of organizational knowledge resources. The proposed role of IT for the creation of organization knowledge capabilities can rationalize IT investments in organizations and provide a basis for user interface customization efforts.

(4) *Implications for practice*: With the extensive use of collective content creation platforms within organizations, we provide a set of decision making criteria for managers and group leaders to optimally employ the resources of their knowledge workers. For instance, managers are usually faced with the tradeoff between breadth and depth of the ideas that are generated in the groups when exposing individuals to their partners' ideas (de Vreede *et al*. 2000). While elaboration and idea integration ensure depth in the discussion, it is desirable that the breadth is also preserved. Insights from our proposed theory can inform technology choices to achieve the desired level of depth or breadth. Furthermore, empirical studies based on the theory proposed here and its extension may prove to be insightful to managerial decision making on the choice of technological tools for enhanced idea integration performance.

Future Research

Although idea generation and sharing provide no benefits to the group and organization unless ideas are integrated, and used (Grant 1996b), the first two are necessary for idea integration within groups. Therefore, the focus of the current theory on idea integration reflects the boundary conditions of the proposed theory. Eventually, a more comprehensive theory of user interface design that addresses all three processes –generation, sharing, and integration – should be developed.

It is also desirable to examine whether the method of prioritization matters. IS research, for instance, has found that having a basis for social comparison improves productivity

but the baseline level does not affect the results (Shepherd *et al*. 1996). A similar question exists for levels and methods of prioritization to discover whether the form of prioritization methods induces a significant change in its effect on idea integration.

Also since information diversity as a key enabler of idea integration is a convoluted upshot of a series of other factors such as members' knowledge repository diversity, time structuring, and social structure of the group, future studies can aspire to promote diversity through the user interface. Moreover since facilitation has been found to be an effective intervention method for boosting productivity (Shepherd *et al*. 1996), it is desirable to study implementation of facilitation mechanisms through user interface which may prove useful in distributed groups.

An advancement of the current theory could be the identification of user interface attributes other than those discussed here and empirical studies of their effect on ideation integration within groups. Some examples of the attributes are structuring presentations of ideas on the screen (several windows instead of one; e.g., Dennis *et al*. 1996), threading feature, and font size (e.g., digg), or color (McNab 2009).

Moreover, future theoretical and empirical studies on how the user interface may be instrumental in reducing several forms of opportunism that occur within brainstorming groups (e.g., free riding, social loafing, and motivation loss) and enhance idea generation, sharing and integration within groups will be complementary to the current research (Pinsonneault *et al.* 1999; Shepherd *et al*. 1996; Zhou & Shalley 2007). An important IS research area where motivation poses some limitations on the current theory is the study of idea integration in groups and teams where traditional incentive mechanisms are not present. It is also important to note that a wide range of individual and social structure characteristics typically influence individual

idea integration behavior (Gruenfeld *et al*. 1996; Rulke & Galaskiewicz 2000), and it is expected that examining individual-specific characteristics will advance theory building in this area.

Summary and Conclusions

The attention-based theory developed here is based on the fundamental logic of Simon (1947) and the concept of bounded rationality, which stems from individuals' limited capacity for attention. We submit that IS user interface can be instrumental in deploying attentional interventions. The current paper also builds upon the cognitive network model of creativity and the ability-motivation framework to link the user interface with human cognition for enabling and motivating individuals to generate integrative ideas. The logical development of this link is a significant achievement for IS research, which has important implications for both IS research and the broader field of organizational science.

The current paper's focus is on the potential of technology for supporting attentional process that advances idea integration (Briggs 2006). The proposed theory can inform the design of user interfaces for facilitating idea integration by laying out processes through which visibility and prioritization influence the phenomenon of interest: idea integrations. The theory developed here subscribes to the IS research quest for improving EBS design, productivity, and efficiency through enhancing idea integration in an era when the speed of idea generation and sharing is sharply surpassing that of idea integration and use. Practitioners are thus counseled to carefully craft and choose the user interface features to foster idea integration when desired.

The current paper also links the IS user interface to the creation of organizational knowledge-based capabilities through facilitating idea integration within groups. Managing cognitive processes underpinning idea integration through IS, thus, contributes to organization's sustained competitiveness.

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