구두 형식의 전자적 브레인 스토밍이 인지적 자극에 미치는 영향에 대한 실증적 연구

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Empirical Validation for Verbal-EBS Effect to Cognitive Stimulation

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Key Words : idea generation, verbal idea generation, brainstorming, cognitive stimulation

Abstract

Given the industry's unprecedented attention and dedication of resources to voice recognition, this paper introduces and explores a novel idea generation technique whereby ideas are captured directly through verbalization rather than forcing group members to type ideas. A group simulator was used to measure the idea generation performance of individuals who input ideas verbally or via typing in the context of nominal and interacting groups. The results clearly indicate that verbal input represents a more desirable mechanism in a computer-mediated idea generation environment. Liberating group members from the keyboard produces remarkable performance gains. Verbalizing ideas helps individuals focus on analytical thinking and leverage group member ideas, ultimately facilitating the creation of ideas pools that are vastly superior in terms of quantity and quality. These effects were found across nominal and interacting groups. The implications of these results for future research and the design of technologies are discussed.

1. Introduction

The idea generation performance of individuals and groups has a long history of investigation. Early work focused primarily on identifying methods of enhancing group creativity and performance using structured techniques such as brainstorming (Osborn, 1957), Delphi (Dalkey, 1969), and the Nominal Group Technique (NGT) (Van de Ven & Delbecq, 1971; 1974). Empirical evaluations of these (and other) group-based methods have consistently found that non-interacting individuals (i.e., a nominal group) whose ideas are pooled consistently outperform interacting groups (McGrath, 1984; Mullen, Johnson, & Salas, 1991). Diehl and Stroebe (1987) investigated various process losses (see Pinsonneault, Barki, Gallupe, & Hoppen (1999) for a detailed procedural, social psychological, and economic list) - specifically, production blocking , evaluation apprehension , and free riding - and concluded that production blocking was the main cause of the poor performance in interacting groups.

While other researchers have explored the potential of mitigating factors such as the use of traine

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d facilitators (Kramer, Fleming, & Mannis, 2001), additional brainstorming rules (Osborn, 1957; Putman, 2001), and leadership style (Sosik, Avolio, & Kahai, 1997, 1998) to account for the discrepancy, a complementary stream of investigation has focused on how computer-mediation could be used to overcome production blocking and other process losses for group idea generation (e.g., Connolly, Jessup, & Valacich, 1990; Dennis, Valacich, Connolly, & Wynne, 1996; Dennis, Valacich, Carte, Garfield, Haley, & Aronson, 1997). In this computer-based research, studies have found computer-mediated group idea generation to outperform non-supported groups for a broad range of group sizes and tasks (Gallupe, Dennis, Cooper, Valacich, Bastianutti, & Nunamaker, 1992). Also, larger computer-based groups (beyond seven to nine members) have been found to outperform nominal groups (Dennis & Valacich, 1993, 1999; Valacich, Dennis & Connolly, 1994a), with few or no differences found between nominal and computer-based groups for smaller group sizes (Gallupe, Bastianutti, & Cooper, 1991; Gallupe, Cooper, Grize, & Bastianutti, 1994; Pinsonneault et al., 1999). This line of work has theorized that the

<Table 1> Idea Production Time Comparison

Study	Experiment Number	Group Size	Ideation Time (seconds)	Per Person Idea Production Time[a] (seconds)
Dennis et al. (1990)	1	2 to 6	1800	121.03
	1	7 to 11	1800	127.30
	1	12 or more	1800	111.91
Gallupe et al. (1991)	1	4	900	118.75
Gallupe et al. (1992)	1	4	900	128.16
	1	6	900	140.79
	2	6	900	78.57
	2	12	900	86.55
Dennis and Valacich (1993)	1	6	900	96.81
	1	12	900	128.06
Gallupe et al. (1994)	1	4	900	167.00
	2	4	900	99.47
	3	4	900	173.21
Valacich et al. (1994a)	1	3	1800	95.95
	1	9	1800	193.80
	1	18	1800	248.90
	3	6	900	82.37
	3	12	900	105.64

[a] All studies reported the number of non-redundant ideas. To provide a conservative estimate of per person idea production time, the calculation was based on the number of unique ideas per person plus one standard deviation. This result was then multiplied by 9.5 seconds, which represents the estimated production time per idea in EBS(Gallupe et al., 1994). These figures are intended to demonstrate a pattern rather than produce precise estimates.

superior performance of computer-based groups is the result of three factors (Dennis & Valacich, 199 3; Valacich et al., 1994a). First, the computer-med iated communication allows all group members to s imultaneously enter ideas, thus reducing productio n blocking. Second, because group members can e asily review the ideas of others, there is a lower le vel of redundant submissions relative to non-intera cting nominal groups. Third, because group memb ers can easily review the ideas of others, there is an opportunity for cognitive stimulation (i.e., syner gy or piggybacking) and enhanced performance. V alacich and colleagues (1994a, p. 463) concluded a series of studies as follows: "The [computer-base d] group appears to be a superior idea-generating technology for large groups, and no worse than the nominal procedure for small groups."

One factor potentially limiting the effectiveness of computer-mediated group idea generation is pro duction time underutilization (Gallupe et al., 1994). Gallupe et al. (1994) report that the average time spent on producing ideas per person represents a mere fraction of the total time available (167 out o f 900 total seconds). Other studies offer consistent results across various group sizes (see Table 1 for a list of studies and per person idea production tim e). One plausible explanation for production time u nderutilization is that members seem to spend the majority of their time not only incubating ideas, but also idling (Gallupe et al., 1994). Another possibilit y involves the need for group member to input thei r ideas via typing. Table 2 provides a list of excer pts from the literature. From this list, a common th eme surfaces regarding the use of the Electronic B rainstorming (EBS) technique for computer-mediat ed groups in which ideas are input via keyboard an

<Table 2> Production Time Underutilization by Typing Ideas

Study	Excerpt
Siegel et al. (1986)	"Computer-mediated communication would be as effi cient as face-to-face communication if group membe rs did not have to type messages" (p. 180)
Dennis et al. (1990)	"Typing is slower than speaking, while reading is fast er than listening" (p. 1051)
Gallupe et al. (1994)	"Participants typed slower than their verbal counterp arts could talk"(p. 82) because "it takes longer to key board an idea than to say it" (p. 84)
Straus and McGrath (1994) see also Kiesler and Sproull (1986)	"EBS requires physical demands of typing as opposed to speaking which may yield less in depth discussion and analysis of issues" (p. 94)
Valacich et al. (1994a)	"Members who cannot verbalize their ideas immediat ely may forget or suppress them because they seem l ess relevant or original later" (p. 451)
Walther (1995)	"CMC users' typing requirement reduces the number of messages they are able to transmit in the same pe riod as Face to Face communicators" (p. 189)

d communicated to other group members through a computer screen. Clearly, the combination of idea generation tasks and traditional input devices (i.e., typing via keyboard) represents a suboptimal mean s to deliver intellectual capital.

Although researchers have long considered that improving communication enhances creativity (Den nis & Valacich, 1993; Dennis &Williams 2003; see also Steiner 1972) and communication speed certai nly represents one of the factors that needs to be examined in improving communication, no known p rior work has examined the positive elements of v erbal ideation (i.e., faster idea production and conv eyance) or investigated the effect of communicatio n speed on idea generation performance. The emer gence of conversational interface technologies suc h as voice recognition may hold the key to realizin g idea verbalization. To this end, this study introdu ces and explores the potential of Verbal-EBS that incorporates voice recognition technology into exis ting Typing-EBS. As an initial step toward theoreti cally and practically understanding the potential of idea verbalization, this study takes an initial step b y focusing on verbal versus typing input modes to establish that verbalization improves idea producti on time and, in turn, increases the quantity and qua lity of ideas generated.

In the next section, we construct a theoretical fr ame work based on orality in communication and c ognitive psychology to develop a set of research h ypotheses. This is followed by a detailed descripti on of the experimental methods and results. The paper concludes with a discussion of the findings a nd the implications for future research.

2. Theoretical Development and Hypotheses

The EBS technique "focuses primarily on elimin ating production blocking without entirely sacrificin g the possibility of [cognitive] stimulation" (Valaci ch et al., 1994a, p. 452). Although production block ing can be mitigated by parallel input, production b locking cannot be completely eliminated because, b y definition, production blocking occurs when an o bstacle hinders the materialization of ideas as they surface. Regarding the benefits related to cognitive stimulation, numerous prior studies have suggested a much less significant influence (i.e., the value of seeing the ideas of others) on the ideational perfor mance of computer-mediated groups (e.g., Barki & Pinsonneault, 2001; Connolly, Routhieaux, & Schne ider, 1993; Diehl & Stroebe, 1987; Dugosh, Paulus, Roland, & Yang, 2000; Garfield, Taylor, Dennis, & Satzinger, 2001; Paulus, Larey, & Ortega, 1995; So sik et al., 1998). We speculate that typing rather th an verbalizing ideas may lead to other, previously unknown, sources of production blocking such as p roduction time underutilization and attention blocki ng to stimuli due to "the greater amount of screen ing taking place under writing [or typing] conditio n" (Lamm & Trommsdorff 1973, p. 374). Thus, if i ndividuals are liberated from the keyboard, they mi ght focus more on analytic thoughts, articulation, a nd leveraging the ideas of other group members. A s a result, verbal idea input should motivate cogniti ve stimulation and, in turn, increase group idea gen eration performance. Below, we review the relevan t literature to motivate our hypotheses.

2.1 Orality Research

Just as the computer-mediated group literature i ndicates a performance advantage in verbal over t yping input while ideating, the linguistics literature also suggest differences in two forms of communic ation to exchange intellectual capital - oral and wri tten. Building on the work of Horowitz and colleag ues (Horowitz & Berkowitz 1964, 1967; Horowitz & Newman, 1964), other linguists (e.g., Biber, 198 8; Chafe, 1982; Halliday, 1989; Jahandarie, 1999) h ave further refined the gradations between the two modes of communication. Among them, Biber's (19 88) work proposes two latent constructs that differ entiate speaking and writing. Biber suggests that t he linguistic characteristics of the two modes are f unctionally and situationally distinct. Functional differences are based on four dimensions – integration, fragmentation, involvement, and detachment. Integration refers to the degree of information density. A typical written sentence is more integrated compared to a spoken sentence due to our educational instruction that "Vigorous writing is concise. A sentence should contain no unnecessary words, a paragraph no unnecessary sentences" (Strunk & White, 2000, p. xv). Fragmentation refers to the degree of looseness in sentence structure. A typical spoken sentence tends to be much more fragmented because of a natural spontaneity and interaction. In contrast, writing, which is entirely artificial (Ong, 1986; Pinker, 1994), must follow a pre-defined grammatical structure. Involvement represents a psychological state related to the degree of interaction between parties. A speaker and listener tend to be more involved because they can interact with each other, whereas a writer and reader typically cannot do so. Speakers tend to talk in an active voice about their feelings, feel more involvement with the reality of here and now, and refer more often to actions and events (Jahandarie, 1999). Detachment refers to the degree to which communication takes place in isolation. In essence, "speaking is a social activity whereas writing is solitary" (Jahandarie, 1999, p. 139).

Situational differences include physical channel, immediacy of feedback availability, degree of permanence, and purpose. Regarding physical channel, speaking utilizes the natural mechanism of the larynx while writing leverages the more labored mechanism of the fingers, wrist, and arm (Horowitz & Newman, 1964). Referring to feedback immediacy, feedback is immediate in speech, whereas feedback in writing consumes more time due to preparation. The degree of permanence between speech and writing differs in that spoken words are transient. They quickly disappear as soon as they are verbalized. On the other hand, written words are preserved on paper. Preservability gives writing a relative permanence that cannot be accomplished via speech. In terms of purpose, writing is typically employed to present information, whereas speaking is generally used not only to convey and share information, but also to establish interpersonal relationships.

In summary, the orality literature points to several advantages to speaking versus writing. Speech (e.g., verbalization) tends foster the conveyance of more contextual information, suggesting its superior efficiency and effectiveness over writing in creating a larger pool of ideas. Horowitz and Berkowitz (1964) summarize this notion in an empirical study by stating, "spoken expression, per unit time, produces more material (words, phrases, sentences), more ideas, more repetitions, and elaborations of ideas, and even more irrelevant ideas than written expression [which may further facilitate divergent thinking]" (p. 619).

2.2 Cognitive Psychology

As group members can symbolically communicate by inputting spoken or written words, EBS utilizes group memory to capture all ideas and allows members to read them on a computer screen. Reading involves cognitive processing to comprehend words and sentences articulated through voice or typing. Because writing includes more passive sentence constructions compared to active voice common to speech, the cognitive-functional approach to language in psycholinguistics indicates that passive and active forms differ in their surface structure(Chomsky, 1957, 1965). Given that native tongues use the active form seven times as frequently as the passive form (Matlin, 2003; Svartvik, 1966), the active form is easier to read and comprehend (Miller, 1962; Miller & McKean, 1964; Williams, 1999; see also Obler et al., 1991) because active structures are more universal and straightforward. Moreover, the comprehension speed of reading is nearly twice as fast as listening (Bailey, 2000; Rayner, 1998). Reading enables information chunking and searching capabilities. "The written signal is perceived in large chunks – that is, several words at a time – with each eye fixation (saccade)" (Jahandarie, 1999, p. 152).

Visual attention augments performance by facilitating a top-down or bottom-up search for external information (Chun & Wolfe, 2000). This flexibility fosters greater exploitation and assimilation of information, which may lead to more creative and novel ideas. As such, the combination of verbal input and idea reading takes full advantage of the rapidity in verbal ideation and reading comprehension, clearly seems advantageous compared to a system by which individuals type and read ideas to exchange intellectual capital.

Taken together, group, cognitive psychology, and orality research suggests that the combination of verbal input and reading disrupts natural communication modes (i.e., speaking and listening vs. writing and reading), while combining the best of each (i.e., speaking and reading). Although EBS sacrifices certain cues such as speech tone, facial expressions, gestures, and paralanguage, suppressing these peripheral cues is preferred for the conveyance of intellectual capital in an idea generation task (Hollingshead, McGrath, & O'connor, 1993). Verbalizing ideas and reading the ideas of others limits elaboration via the natural communication mechanism; cultivates improved contextual information, offers simpler sentence structures for reading and comprehension, and increases attention to important pieces of information at the right moment, as group members are no longer preoccupied with typing . As a result, verbal input should increase idea production time and enhance cognitive stimulation by hastening idea building or piggybacking. Based on these notions, verbal input is envisioned to represent the most ideal form of EBS in an idea generation context.

H1: Individuals with (nominal and interacting) Verbal-EBS will outperform (quantity of and total quality score of ideas) individuals with (nominal and interacting) Typing-EBS.

In nominal groups, Paulus et al. (1995) examined the effect of idea verbalization using tape recorders rather than writing, reporting that "electronic brainstorming procedures do not match the output of nominal groups that respond orally." (p. 261). This seems to set a new precedent in idea generation. However, these findings can be viewed as inconclusive. The performance of interacting and nominal Verbal-EBS groups was not directly compared because robust voice recognition technologies were unavailable at the time. Verbal ideation addresses a central flaw suggested by group researchers in that searching for good ideas generated by others to build on is possible while speaking, but not while writing or typing (Dennis, Valacich, & Nunamaker, 1990). By combining speaking and reading, inputting ideas verbally can potentially supercharge interacting group performance. Interacting groups that input ideas verbally take full advantage of attentional resources, which fosters cognitive stimulation (Dugosh et al., 2000). The flood of ideas and corresponding stimulation should result in interacting groups that outperform nominal groups that utilize verbal input (Paulus et al., 1995) or groups that type ideas. Thus, the following hypothesis is offered:

H2: Input mode (verbal vs. typing) will interact with group type (interacting vs. nominal) such that individuals with interacting Verbal-EBS condition will have the highest performance.

Studies (Gallupe, DeSanctis, & Dickson, 1988; Hiltz, Johnson, & Turoff, 1987; Parks & Sanna, 1999) frequently suggest that depersonalization of computer-mediated groups leads to less satisfaction than in face-to-face groups. In particular, Jessup and Tansik (1991) and Sosik et al. (1998) point out that anonymity supported by traditional EBS detaches a group member's attachment to his or her comments. Given prior studies' suggestions, it is speculated that part of the explanation of deindividualization might be in the nature of writing. As pointed out in the speaking vs. writing section, the nature of writing includes more passive voice in sentences, whic h means less personal involvement, resulting in higher abstraction, decontextualization, and detachment. In other words, writing is more adequate for highly objective informational tasks that require some degree of detachment between participants such as judgment, decision-making, or negotiation tasks (Biber, 1988) whereas, speech usually occurs in the process of interpersonal interaction. For this reason, oral discourse is accompanied by a greater sense of involvement, which is more "phatic."

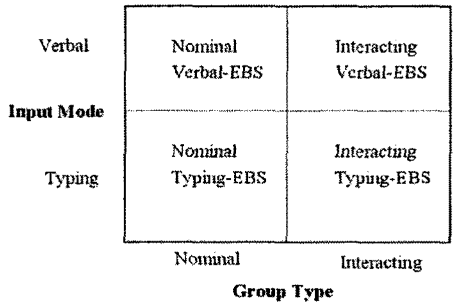
Although the definitions of involvement and detachment, which are the two characteristics to distinguish speaking and writing, may not be adequate in traditional Typing-EBS context because participants can still dynamically interact with one another through the electronic channel, Verbal-EBS that simulates participants to speak ideas and respond to the ideas of others as if they were conversing with others (but, without nonverbal cues) seems more playful due to reduced efforts both cognitively and physiologically (e.g., elimination of attention blocking and typing). Webster and Martocchio (1992) suggest that computer playfulness is positively related to involvement and satisfaction. Venkatesh (2000, p. 349) further suggests that "higher levels of computer playfulness lower perceptions of effort - i.e., for the same level of actual effort/time invested, perceptions of effort/time will be lower in the case of a more "playful" user when compared to a less "playful" user." It is expected that this will lead to an increased perceived interaction and, in turn, a better satisfaction than traditional Typing-EBS. Thus, it is hypothesized that:

H3: Individuals in the Verbal-EBS condition will have higher satisfaction than individuals in the Typing-EBS condition.

3. Methodology

3.1 Research Design

A 2 × 2 between-subjects, factorial design was used, crossing input mode (typing or verbal input) and group type (nominal or interacting) shown as Figure1. Participants were randomly assigned to one of four treatment conditions. The operationalization of input mode and the manipulation of group type are described in detail below.



<Figure 1> Research Design

3.2 Participants

Overall, 411 upper-division business students from a large state university in the United States participated in the study. In return for their time and effort, course credit corresponding to less than one percent of their overall grade was awarded. To develop a pool of ideas for the stimulated group brainstorming environment and to assist in the design of the group simulator, 311 individuals participated in a series of pilot studies. The remaining 100 individuals (25 per cell) were utilized for hypothesis testing. International students were excluded from the sample, as the pilot studies revealed that these individuals generated substantially fewer ideas due to difficulty verbalizing ideas in real-time English, causing excessive delays and/or errors in the voice transcriptions. The average participant age was 21.03 years (SD = 3.34) and 62.0% were male.

3.3 Task

Participants were asked to generate ideas on "How can we improve the university's parking problem?" This task was chosen for its high relevance - since it stimulates participants to draw on their per sonal knowledge and experience - and because it has been used in many prior studies(e.g., Connolly et al., 1990; Garfield et al., 2001; Jessup et al., 1990).

3.4 Input Mode Operationalization

For the communication medium operationalization, participants either typed ideas directly into a groupware system or spoke ideas that were automatically transcribed and entered into the system. Although the mechanisms by which ideas were input differed, all participants used the same groupware system.

To facilitate the verbalization, transcription, and entry of ideas, the latest voice recognition software available on the market (e.g., Dragon Naturally Speaking, IBM Via-Voice) was integrated with the groupware system. The software was thoroughly tested in the pilot studies to ensure high levels of accuracy and efficiency, which are considered the most important factors in determining software performance (Rebman, Aiken, & Cegieski, 2003). Despite manufacturer claims, two significant limitations were discovered. First, the current state of the technology prevented transcriptions from achieving 100% accuracy - a necessary condition to enable task execution. Second, participants had to dedicate substantial preparation time for the software to successfully learn how to transcribe their voices at even a 95% accuracy level. As a result, participants questioned the software's quality and, thus, were reluctant to rely on it as a means to input ideas.

Based on the technological shortcomings encountered, a decision was made to abandon the voice recognition software in favor of a professional transcriber, who was able to enter ideas into the groupware system at the participants' regular rates of speech. Although a professional transcriber was utilized in lieu of voice recognition software, participants using the Verbal-EBS communication medium in the experimental sessions were told that the latest voice recognition software had been installed on the workstation. Rather than typing ideas, they were asked to speak their ideas into a microphone. The software would then automatically convert their verbalized ideas and record them in the groupware system.

3.5 Group Type Manipulation

Participants assigned to nominal groups were informed that they would work independently using a groupware system that would record their ideas. Instructions for interacting groups differed in that participants were told that they would be working with other team members who were randomly assigned to the group. They were also advised that all team members would utilize the same groupware system, which would allow the exchange of ideas among team members.

3.6 Simulated Interacting Groups Using a Group Simulator

Nominal group members worked in isolation, meaning that the groupware system did not expose participants to the ideas of others. For interacting groups, however, a simulator was designed to accurately control the presentation of ideas in order to control error variance that inevitably occurs in interacting groups (Brown & Paulus, 1996; Brown et al., 1998; Garfield et al., 2001; Hilmer & Dennis, 2001). As a result, the simulator yielded a more accurate and controlled measure of individual performance. Garfield et al. (2001) describe a group simulator as an electronic environment that "looks and acts like a groupware system, but instead of sharing ideas among participants, the simulator presents participants with comments that appear to be from other participants but which are, in fact, drawn from a database of preset ideas" (p. 327).

To populate the simulator's idea database, 18 five-person group idea generation sessions were conducted in the pilot sessions to collect a large pool of ideas for the experimental task. After removing redundancies, 193 unique ideas were identified. Th ree domain experts representing senior employees from the campus Department of Parking Services were asked to rate the quality of each idea using a 7-point Likert scale anchored by 1 (A Very Poor Solution and 7 (A Very Good Solution). Any ideas assessed by the experts as "ridiculous" were discarded. A Cronbach's inter-rater reliability of .93 indicated that the expert ratings were highly consistent. As such, the mean of the three ratings was used as an index of idea quality. Consistent with prior studies (Diehl & Stroebe, 1987; Dennis et al., 1999), the scale midpoint was utilized as the threshold to determine idea quality. Specifically, ideas with an average rating of 4 or higher were considered high quality, whereas the remaining items were categorized as low quality. From this pool, 50 ideas were randomly selected to simulate interacting group members, as the pilot studies with interacting groups consisting of five members generated approximately 50 ideas. Moreover, because interacting groups typically generate a mixture of high and low quality ideas, 25 of each kind were utilized.

The simulator closely mimicked the sequence of a real, interacting group idea generation session in a way that idea seeds are presented sequentially to the subjects. We see a downward linear relationship between the number of ideas generated over time within real, interacting group idea generation sessions (see Connolly et al., 1993; Brown & Paulus, 1996). This relationship is represented by many ideas in the early stage and fewer responses toward the later stages, running out of ideas in the end. This pattern of idea presentation was controlled via programming.

Pilot testing confirmed that the simulator accurately reproduced the sequence and interactions of a real, interacting group idea generation session. Within the experimental sessions, a post session question asked each participant "How many people do you think you were working with on this task?" On average, participants reported 4.29 members (SD = 0.99). Thus, it appears that participants believed that they were working in a real, interacting group, further validating this approach for enforcing greater experimental control.

3.7 Dependent Variables

Two measures were collected and analyzed in this study: total ideas and quality score. Total ideas reflect all ideas submitted by participants after removing redundant ideas, whereas quality score represented the sum of the average expert quality rating for each idea. The manner by which these measures were operationalized is consistent with many prior studies (e.g., Connolly et al., 1990). To measure quality score, ideas generated by participants were first matched to the master list compiled based on the pilot studies. During the experimental sessions, 44 novel items were generated that were not captured on the original master list. Using the same procedure outlined above, three domain experts independently judged the quality of the new items. Ratings demonstrated adequate inter-rater reliability (α = .88). As a result, all items generated by participants were included in the analyses.

3.8 Procedures

On reporting to the experimental site, participants were assigned to a workstation within a computer classroom that contained 50 separate workstations. Experimental sessions associated with the Typing-EBS communication medium ranged from 10 to 20 participants. Because a professional transcriber was required to facilitate the verbal input mode, experimental sessions were conducted on a one-by-one basis. Specifically, each individual sat at a pre-specified workstation to which a microphone was attached. The professional transcriber, who was located in an adjacent room, listened through a wireless communication device that was connected to the microphone. The professional transcribed and entered ideas into the groupware system as they emerged. Despite the inability to implement voice recognition software, pilot testing revealed that parti cipants believed that the system was automatically transcribing their spoken ideas and were unaware of the transcriber's role or presence.

Participants were invited and allowed to become familiar with the operation of the groupware system prior to the main task by first working on a practice task. Each participants' contributions and idea seeds (interacting groups only) from the database were anonymous. The experimenter then read aloud the experimental instructions to generate as many high quality ideas as possible while the participants followed in their own copies. Participants were also told that their results would be used to improve the university's parking problem.

After participants had completed the practice task, they were instructed to start working on the experimental task. The simulator was programmed to permit idea entry for a 15 minute period, after which participants completed a brief questionnaire, were debriefed, and were released.

4. Results

Table 3 and 4 present a summary of the means, standard deviations, and results for individual performance. Hypothesis 1, which stated that individuals with Verbal-EBS will outperform individuals with Typing-EBS, was supported. Because the dependent variables Total Ideas and Quality Score were highly correlated ($r = .80$, $p < .001$), a two-way MANOVA was utilized. A significant effect for input mode was revealed (Wilks' $\Lambda = .86$, $F(2,95) = 52.57$, $p < .001$, $\eta2 = .53$). Follow-up two-way ANOVAs also found significant effects for input mode on Total Ideas ($F(1, 96) = 53.73$, $p < .001$, $\eta2 = .36$) and Quality Score ($F(1, 96) = 106.12$, $p < .001$, $\eta2 = .53$).

Hypothesis 2, which stated that input mode would interact with group type such that individuals in interacting groups who input ideas verbally would achieve the highest performance, was not supported. Neither the two-way MANOVA (Wilks' $\Lambda = .99$, $F(2,95) = .71$, ns, $\eta2 = .00$) nor the follow-up two-way ANOVAs reported above showed no interaction effect between input mode and group type for Total Ideas ($F(1, 96) = .09$, ns, $\eta2 = .00$) or Quality Score ($F(1, 96) = .14$, ns, $\eta2 = .00$).

Hypothesis 3, which stated that individuals with

<Table 3> Means and Standard Deviations for Individual Performance

	Communication Medium	
Dependent Measure	Typing	Verbal
Total Ideas		
Nominal		
M	7.800	13.440
SD	3.969	4.042
Interactive		
M	9.400	15.520
SD	3.354	4.584
Total Quality Score		
Nominal		
M	24.234	46.160
SD	10.182	12.204
Interactive		
M	23.554	47.136
SD	8.603	12.699
Satisfaction		
Nominal		
M	14.880	14.880
SD	3.032	2.920
Interactive		
M	15.820	16.080
SD	3.744	3.378

<Table 4> Statistical Results

			F	p	η^2
H1:					
	Total Ideas		53.73	.000	.359
	Quality Score		106.12	.000	.525
H2:					
	Total Ideas				
		Input Mode (IM)	53.73	.000	.359
		Group Type (GT)	5.26	.024	.052
		IM X GT	.09	.765	.001
	Quality Score				
		Input Mode (IM)	106.12	.000	.525
		Group Type (GT)	.00	.947	.000
		IM X GT	.14	.709	.001
H3:					
	Satisfaction		0.039	.844	.000

Verbal-EBS will have higher satisfaction than individuals with Typing-EBS, was not supported. The perception of satisfaction was measured by three items: How do you feel about the process by which you generated ideas? How do you feel about the idea proposed? All in all, how did you feel? (Cronbach's α = .88). We compared aggregates of nominal and interacting Verbal-EBS to aggregates of nominal and interacting Typing-EBS. A one-way ANOVA showed no statistical significant difference in satisfaction ($F(1, 98) = 0.039$, $p = .844$, $\eta^2 = .00$). Also, post-hoc Tukey tests (at a = .05) showed that all pairs did not statistically differ.

5. Discussion

The study reported was conducted to enhance our current understanding of the effect of verbal input on idea generation performance in a computer-mediated group environment. In particular, the current study examined whether group performance using verbal input differs from traditional typing input. As envisioned, individuals using the verbal input mechanism, regardless of group type, performed far better than individuals who typed ideas, strongly supporting that idea verbalization constitutes a more desirable input mode in a computer-mediated idea generation task. The combination of speaking and reading is clearly superior to typing and reading.

Regarding verbalization, the ease by which ideas can be put forth and the less effortful mode of expression certainly constitute principal forces by which performance differences are produced. Compared to speaking, writing (e.g., typing) requires a more serious physiologically and psychologically commitment (Horowitz & Newman, 1964). The data also show that voicing ideas produces a far greater quantity of information than typing. This notion is consistent with the literature in that "spoken expression produces significantly more cognitive and linguistic material than written expression" (Horowitz & Berkowitz 1964, p. 619). In addition to quantity, idea verbalization led to higher quality ideas. Thus, it is possible to maintain that "quantity helps breed quality." As for reading, the capability of individuals to process and search information in parallel provides readers an additional edge in acquiring information. In turn, more novel and useful ideas were generated, resulting in dramatic performance improvements.

From an economic analysis perspective, the costs associated with an individual's contribution (i.e., effort) represent an important determinant of motivation. Typing demands increased physical and cognitive effort, divides cognitive attention between keyboarding and reading a computer screen, and pr esents greater challenges to overcoming attention blocking. In addition, writing requires more cognitive elaboration than speaking. Most people attempt to draft a presentable exposition consisting of complete sentences and acceptable grammar. They also tend to read their production before disseminating (Horowitz & Berkowitz, 1964). In comparison, verbalization involves a rather effortless and spontaneous process, reducing physiological and cognitive effort. In an economically sense, the less effortful mode of verbal input serves as a natural motivator, allowing participants focus then attention, comprehend information, and ultimately capitalize on others' ideas leading to far better performance.

Regarding satisfaction, although there was no statistical difference between individuals with Verbal-EBS treatment and individuals with Typing-EBS treatment, more close examination of the data show that individuals with interacting EBS (regardless of verbal or typing) expressed more satisfaction than individuals with nominal EBS. As for the individuals with interacting EBS, one interpretation is that people in groups tend to overestimate their performances (Stroebe, Diehl, & Abakoumkin, 1992), which may lead to higher satisfaction. Expanding on the above explanation, interacting Verbal-EBS subjects may have shown a statistically significant satisfaction difference compared to other treatments. One possible explanation is that although Verbal-EBS is a much easier way to express ideas, the younger generation represented by this sample (a.k.a. the Net generation) has grown accustomed to electronic communication through typing such as e-mail, instant messages, etc.

5. 1 Implications for Research

Based on the central finding that individuals who use verbal input perform far better than typists, there is clearly an opportunity to extend this research to a real, interacting group with voice input facilitated through professional transcribers. Due to cognitive interruption that occurs when participants simultaneously speak, as well as software complications that make it difficult to distinguish participant voices, same time / same place groups present considerable operational challenges. As such, distributed groups need to be utilized. However, prior studies demonstrate that physical proximity reduces the performance of computer-mediated groups (Valacich et al., 1994b). Moreover, although the presence of others can result in a positive side effect in the form of social facilitation (Bond & Titus 1983), Paulus and Dzindolet (1993) conclude that the effect of others' presence is not considerable enough to influence group brainstorming outcomes.

The findings also offer a clue to overcoming Paulus et al.'s (1995) notion that "electronic brainstorming procedures do not match the output of nominal groups that respond orally" (p. 261). Due to the tendency of individuals in interacting groups to engage in spontaneous arguments based on the ideas of others, the data found no individual performance difference between interacting and nominal groups that typed or voiced ideas. This insight reinforces the widely accepted group brainstorming rules (Osborn 1957) in idea generation sessions. As Wheeler and Valacich (1996) point out, procedural guidance (i.e., brainstorming rules) lacks the ability to restrict the group interaction process in exchanging ideas. They further suggest that a new set of EBS technology features could remind participants to follow rules. Examples that researchers may want to consider include periodic, time-based popup announcements and artificial intelligence techniques that recognize specific words as cues to trigger specific reminders.

The application of a group simulator also represents a promising for future research. Connolly et al. (1993) point out that cognitive and motivational domains remain uncharted territory and urged the pursuit of individual level approaches to investigate cognitive and motivational stimulation. Since the level of analysis using a simulator involves individuals, this opens up many possibilities for exploring additional factors that may influence cognitive and m otivational stimulation at the individual level. Also, the use of a simulator dramatically reduces the number of subjects needed, while simultaneously increasing predictive precision by controlling error variance that inevitably occurs in actual, interacting groups (Hilmer and Dennis 2001).

5. 2 Implications for Practice

Gray and colleagues (1993) state, "to the user, the system is the interface" (p. 192; see also Moran 1981). As such, the user interface constitutes the most critical aspect of GSS and, in general, information systems. For the user, the interface represents the sole portion of the system that is tangible and meaningful, while the rest is invisible. "[A] goal of the interface is to help users feel like they are reaching right through the computer and directly manipulating the objects they are working with" (Mandel 1997, p. 60). As part of designing a GSS interface (see Gray et al., 1993 for detailed issues related to design), there are a variety of input devices such as typing, touch screen, mouse, and voice input. Among them, voice input is the only one that does not require the skill and learning time (assuming 100% accuracy of the technology). Naturally, computer users prefer the easiest interface available (Davis, Bagozzi, & Warshaw, 1989). Given the findings, it is strongly believed that human-computer interaction through speech will set the sail for a new era of user-friendly computing. Advancements in voice recognition technologies, however, will need to take place beforehand.

Along these lines, although the dissemination rate of computers is continuously expanding, many people (in particular, middle-aged managers) remain intimidated by computers and their accoutrements (Gray et al. 1993). At best, keyboards may be perceived as an inconvenient, unnatural input mechanism for most decision makers. As anyone who has recently interacted with an automated call center can attest, voice recognition - one of the final frontiers in human-computer interaction – is permeating organizations at a rapid pace. Consequently, verbal input has impacted several business areas and will likely continue to be applied in an increasingly broader range of business settings. Typing requires more physiological and cognitive effort, which are important determinants of motivation. The results of this study help system designers understand how and why verbal input is a more natural human-computer interaction and how this input mode enhances performance. We encourage practitioners to consider verbal input as a primary user interface, especially in group brainstorming environments. Briggs and colleagues (1997/1998) point out that the slow diffusion of EBS in organizations has been hampered by interface issues. As systems become more user-friendly and demonstrate the potential for noticeable productivity increases, voice recognition may ultimately contribute to the broader diffusion of groupware systems.

5. 3 Limitations

Like any research undertaking, this study is limited in certain respects. There are obvious issues related to external validity. We employed a laboratory experiment with student participants in a simulated group idea generation environment. These participants also had no significant stake in the outcome of the task. Although they understood the task and appeared to participate adequately, these individuals are not typical decision makers for this task domain. Yet, the task was germane to their situation as university students. In addition, the use of a group simulator moves away from a natural group setting. Nevertheless, while we may not be able to generalize our findings to all forms of group idea generation and all types of groups, we can probably generalize to groups of concerned participants asked to generate ideas on an issue that directly concerns them. Additional research is needed to understand the extent to which these findings may generalize to different environments, tasks, subject configurations, and contexts.

Another limitation relates to the lack of sophistication in current voice recognition technologies. As our pilot studies revealed, attempts at using existing technologies as a means to automatically transcribe and enter ideas proved troublesome and difficult to use. Because ease of use represents one of the major determinants of intention to use (Davis et al., 1989), software packages in their current form have not sufficiently advanced to the point where participants find them effortless. In fact, many difficulties and delays were experienced in configuring and tailoring the software to recognize a specific participant's voice. Moreover, performance in terms of accuracy and efficiency was severely hampered during real-time verbalization, which led to frustration. To fully benefit from the potentials of voice recognition technologies, performance improvements must be made in order to make the technology a viable alternative.

In a similar vein, the verbal input treatment was conducted on a one-by-one basis, whereas those assigned to the typing input treatment were in the same room with 10 to 20 other participants. This experimental design was needed to control for cognitive interruption, participant voice discernment, and to enable the professional transcriber to listen and enter a participant's ideas as s/he spoke. As such, social influences that may have affected the results cannot be ruled out entirely. Although conducting the sessions consistently across communication medium treatments would have provided the tightest controls possible, the implemented approach was necessary to emulate voice recognition technologies and take an important first step toward examining the effects of idea verbalization. We encourage researchers to consider alternative approaches in group idea generation contexts.

Finally, the unequal gender distribution of participants reflects another limitation. This study, however, ran t-tests to examine any performance differences based on gender in each experimental condition and found no evidence support a gender effect. This finding is consistent with prior studies (Herschel, Cooper, Smith, & Arrington, 1994; Klein & Dologite, 2000) that have investigated the influence of varying gender compositions, finding no gender effect in idea generation tasks.

6. Conclusion

There are many factors such as group size, proximity, cohesiveness, composition, and so on that can influence group interaction and performance. Among them, alternative techniques of inputting ideas to enhance group productivity have been one of the least studied. In this study, we specifically investigated the effect of input mode (i.e., verbalizing or typing idea) or communication speed on ideation performance. Although communication speed as potential process loss has been around for more than several decades across disciplines, due to extreme technical implementation difficulty on the side of voice recognition, it has been speculated that there may be some minor effect (Dennis & Williams, 2003). In other words, the extent of its effect has simply been unknown. The results of this study suggest that inputting ideas verbally produces remarkable performance gains. These effects were found across nominal and interacting groups, indicating that communication speed needs to be considered as one of the fundamental factors that may break the contingent balance between process gains and process losses in enhancing the group productivity (Connolly et al., 1990, Pinsonneault et al., 1999). While the implications of these findings to other group configurations, tasks, and contexts are not yet fully understood, the findings are encouraging. Nonetheless, many interesting questions and opportunities remain.

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