Group Awareness Information in Web-Based Group Decision Support System

Nipat Jongsawat

Graduate School of Information Technology in Business
Siam University
Bangkok, Thailand
nipatj@yahoo.com

Wichian Premchaiswadi

Graduate School of Information Technology in Business
Siam University
Bangkok, Thailand
wichian@siam.edu

Abstract— **Group awareness information is important information of group work. It represents the kinds of things such as group member's roles and responsibilities, their positions on an issue, their status, and the state of various group processes that group members know when they work together. The group awareness information presented in this paper is designed to capture group member activities and their behaviors in web-based collaborative work. The group awareness information is represented with the visual display. It consists of activity, availability, commitment/disposition information. The prototype of this proposed schemed is designed and implemented in web-based group decision support system. The visualized group awareness information can stimulate the group members to generate more ideas, produce higher quality of the given task, produce a higher number of communications in group, and increase cohesiveness among team members.**

Keywords— **web-based group decision support system, nominal group technique, group awareness information, activity information, availability information, commitment/disposition information**

I. INTRODUCTION

In traditional or face-to-face group meeting and/or group decision support, group members working in close physical proximity have access to a large amount of information about one another. This includes such things as the presence or absence of members of the work group, what they are working on, who they are working with, how actively they are working, how they feel physically and emotionally, etc. This information is obtained directly through communication and indirectly through observation of shared artifacts [1]. Computers are being used to assist in cooperative tasks [2]. When people collaborate via computer mediation, this information and the opportunity to access it are diminished. Increasing the amount of information about the group availability in a computer mediated collaborative support system should increase the group's ability to complete task. When people work together, they share a task on which they cooperate, one or more artifacts, and a social context. Supporting awareness of the activity of other members in the collaboration team and of changes in the shared work materials are very important in collaborative work systems [3]. Tatar [4] found that people required up-to-date information about others, e.g. who just made a modification, to collaborate effectively in "What You See Is What I See" (WYSIWIS) systems. Moran and Anderson

[5] suggest that awareness information is important because it provides information about availability in an indirect way. Generally, people pay attention to the activities of others. The presence and behavior of other people helps to define the meaning of situations of the individual and can have an influential effect on his or her behavior, attitudes, and feeling in interaction in group-work situations [6]. This research outlines issues and opportunities related to the use of tools to improve collaboration. Specifically, it discusses increasing awareness information and information about the status of individuals contributing to the collaboration.

Research on computer-supported communications has been on going for over 20 years. A variety of computer-mediated systems have been developed to support group meetings. Group Decision Support Systems (GDSS) have been defined as "an integrated computer-based system to facilitate the solution of unstructured or semi-structured tasks by a group that has joint responsibility for performing the specific task" [7]. Power et al [8] defines a web-based decision support system as DSS built with web technologies so that the DSS users access it with web browsers deployed on corporate intranets to support internal business processes or they can be integrated into public corporate web sites to enhance services to trading partners. The goal of web-based GDSS is to achieve a final group decision with a high level of quality and effective consensus needs. Web-based GDSS has been well established and continually developed since year 2000. Researchers have proposed various methods in Web-based GDSS in order to achieve the highest quality of group decisions or tasks. In our literature review, no researchers have considered awareness information as a way to increase the quality of group decision making yet. In this paper, we propose the methods of designing and establishing group awareness information as visual information in web-based group decision support system and representing them to the group members when they work together in the given group tasks. Each section is organized as follows: Section II addresses in a little more detail about various aspects of the awareness information. Section III addresses about the related work. Section IV describes design and implementation of group awareness information in Web-based GDSS in more detail. Section V describes presents conclusion and gives some perspectives and ideas for future work.

II. BACKGROUND

There are a lot of theories concerning awareness information and cooperative work, but this paper only provides a subset of them. These specific theories have been chosen because they appear to be most applicable to the analysis and design of group awareness information in web-based group decision support system.

A. Awareness Information

The word awareness, when used in the context of computers, can be defined in many different ways depending on how it is applied and who applies it. Awareness is "an understanding of the activities of others, which provides a context to your own activity" [9]. Greenberg and Johnson [10] present three steps that must be taken to support awareness in collaborative work. First, determine what people need to know about others in the work setting. This information could be used to model the frameworks of what people need for maintaining awareness in the groupware setting. Second, consider how that knowledge can be gathered and interpreted into the information available in the groupware setting. Third, determine how to display that information so that people can obtain and use the knowledge naturally and effortlessly. Maintaining awareness information in a work setting uses two mechanisms. The first is communication, which can be direct or indirect. People in the work setting may inform others by communication about where they are going to work and what they are going to do. Second, people can gather awareness information by watching others work or by noticing the effects of their actions, which is observation [11]. Therefore, groupware needs an interface through which to present awareness information. The system displaying awareness information must provide some balance between providing awareness and distracting people from their tasks or violating an individual's privacy by giving out too much information. These decisions are complicated in that "awareness" as a natural phenomenon is difficult to observe because it is a cognitive activity. Good metrics of "awareness" do not exist [10].

B. Type of Awareness

There are several kinds of awareness that can be seen in group work. Gutwin [12] provides four types of awareness in group work.

Informal awareness: A general knowledge of who is around and what they are doing. They are the kinds of things that people know when they work together in the face-to-face environment. This kind of awareness can facilitate causal interaction.

Social awareness: Social awareness is awareness about the social situation of the members, i.e., awareness about what they are doing, what they are talking to someone, if they can be disturbed, whether another person is paying attention, their emotional state, or their level of interest, etc. Social awareness is maintained through conversational cues such as through non-verbal cues like eye contact, facial expression, and body language.

Group-Structural awareness: The knowledge about people's roles and responsibilities, their positions on an issue, their status, and the state of various group processes.

Workspace awareness: It is the collection of up-to-the minute knowledge a person holds about the stage of another's interaction with the workspace. Workspace awareness emphasizes the role of the workspace in collaborative activity.

There are other kinds of awareness in the literature, which are organization awareness and situation awareness. Organization awareness represents a relationship of people, knowledge of how the group activity that fits in with the larger purposes of an organization, their rationales for being together and their shared knowledge [13]. Situation awareness is explained as an understanding of the components in the environment at a particular moment in time and space, the comprehension of their meaning and the projection of their status in the near future [14]. Situation awareness alters depending on the perceived significance of situational information; sometimes moment by moment in a dynamic environment [14]. Situation awareness was described in the U.S. Force's Intraflight Command, Control, and Communication Symposium final Report (1986) as the single most important factor in improving mission effectiveness. The maintenance of social awareness in distributed groups has been explored in CSCW through desktop videoconferencing [15], video tunnels [16], or the mixing of video and computational workspaces to allow eye contact within a work surface [13], [17].

This paper has developed prototypes to support informal cooperation in an online work group and group decision making by using awareness information displayed in web-based environment that uses the following information: activity, availability, and commitment/disposition. Awareness information used in a web-based GDSS, in this paper, is defined as group awareness information.

III. RELATED WORK

Collaborative systems have endeavored to support the accomplishment of some tasks. A number of collaborative systems have attempted to build the same atmosphere of causal awareness and informal interaction between people in separate places. These systems have a range of techniques from symbolic systems through media spaces to support distributed work groups through access to information that supports generate awareness [18]. There are three kinds of techniques and systems that support awareness: Real Time Systems, and 3D Virtual Spaces Systems, and Symbolic Systems [19]. In this section, the symbolic system is only described because this paper works on this issue.

Michael [19] presents an awareness tool in CASCADE (Computer Augmented Support Collaborative Authoring and Document Editing). CASCADE is designed to allow groups of people to work together on documents. One goal of CASCADE is to reduce the cognitive overhead in the authoring of structured documents by employing a variety of information streams, augmented processes and software tools. An awareness tool in CASCADE presents the user with a set of pictures of group members who are currently using

CASCADE. As the group members start and stop sessions, the gallery of pictures is updated to reflect the identity of members who are available. Clicking on a picture starts an interactive talk session with the selected user. The social awareness tool was integrated into a version of CASCADE. The awareness tool shows the level of user activity, the current focus of their efforts, and their disposition to engagement. Figure 1 shows the CASCADE system with the social awareness tool. The awareness information presented is generated from user activity and tied to individual documents. It is constantly updated based on the activity of the group members. The sharpness of the image is a reflection of how active they are.
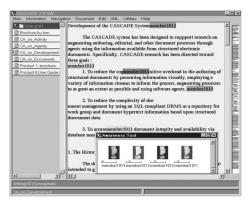

Figure 1. CASCADE with a social awareness tool.

The above system is frequently referred in the literature. This paper only focuses more on symbolic system like CASCADE. The information of individuals during collaborative or group work is captured and represented with pictures or icons with explanation to the group members. These pictures presented are generated from member activity, availability, and commitment/disposition. The details are described in the next session.

IV. Design and Implementation of Group Awareness Information in Web-based GDSS

A. Three factors in Group Awareness Information

There are a variety of factors that people uses in assessing other socially in a collaborative work situation. In this research on Web-based Group Decision Support System, activity, availability, and commitment/disposition are selected as three factors for transforming the captured data into visual data displaying in the World Wide Web environment because they appear frequently in the literature. There are various operational definitions for each of these factors. They are operationally defined in Web-based Group Decision Support System as follows:

1) Activity information is information about what others in group are doing or have done. It was operationally defined as the summation of amount of contents that a group member edits in the work space (web page) each time divided by the number of minutes for editing contents each time + the summation of amount of contents for each comment that a group member generate to other group members divided by

number of minutes for editing comments each time. See (1). The formula is shown below:

$$\text{Activity} = \sum_{i=1}^{n} \frac{(\text{NoOfContentWord}_i)}{\text{MinContentEdit}_i} + \sum_{j=1}^{m} \frac{(\text{NoOfCommentWord}_j)}{\text{MinCommentEdit}_j} \quad (1)$$

Note that n is the number of time(s) a group member accesses the web page for editing the contents. m is the number of time(s) a group member generates the comment(s). NoOfContentWord is the amount of words (contents) a group member edits in the work space. NoOfCommentWord is the amount of words/comments a group member generates to other members. MinContentEdit is the number of minutes a group member spends time with editing the contents in the work space. MinContentEdit is the number of minutes a group member spends time with generating each comment. It attempts to capture some sense of how active and how engaged, an individual is with respect to a group work in web-based group decision support environment. Activity is defined in the study as a function of the size of the contents in the web page, the number of times it was accessed, the number of minutes it was added or edited, and the number and amount of comments that a group member generates. If the activity value is high, it means that a group member is more active during his or her work.

2) Availability Information is information about who is around and available for the others in the group. It was operationally defined as the number of minutes connected divided by the expected number of minutes connected (determined per task) + a self assessment rating of how busy each group member is + a rating of the delta of availability + a degree of activity. See (2) and (3). The delta factor indicates whether group members are becoming more or less available over a set of time periods. That is, it indicates whether availability is increasing or decreasing. The formula is shown below:

$$\text{Availability} = \frac{\text{MinConnected} + \Delta P + \text{CLR} + \text{ACT}}{\text{ExpMinConnected}} \quad (2)$$

$$\text{where} \ \ \Delta P = \frac{P_n}{\left(\dfrac{P_i + \ldots + P_{n-2} + P_{n-1} + P_n}{n - i}\right)} \quad (3)$$

Note that MinConnected is the number of minutes, which a group member connects to the system to complete a task each time over a given period. ExpMinConnected is the number of minutes, which a group member is expected to spend on a task each time over a given period. ΔP is number of minutes connected in time n over number of minutes connected in any period of time from i to n for a particular user when Pi is number of minutes connected in time i (starting period); Pn-2 is number of minutes connected in time n-2; and Pn is number of minutes connected in time n (ending period). Current Life Rating (CLR) is Self Assessment. Group members rate their current life using the scale 5 to 1 (very busy, busy, normal, not

busy, and comfortable) respectively. ACT is the degree of activity. It is obtained from the calculation of activity shown in previous formula using scale 5 to 1 (not active, less active, fair, active, and very active) respectively. If the availability value is high, it means that a group member is less available for other members because he or she might have a lot of things to do at the moment and have no room for other tasks.

In social relationships, members use availability information to help them process their interactions in an environment [5]. On one hand, availability of other members in a team can be perceived through their reliability, work ethics, or productivity. If we can rely on a person in our group, we consider that person as an available member. If a person works very hard or more than would be expected, we could say that a person should be available for us. If a person doesn't work very hard, we might think that they would not be available for helping us in completing a task. On the other hand, if a person is working and still has time left, we might also consider that person as an available member. In this case, it is an availability to do more. If a person is working longer than the expected time to complete a task, we might consider that person is not available.

3) Commitment/Dispositio*n* is defined as information about how willing a group member is to do more, which includes how he or she views the project positively or negatively. Operationally, this value was calculated as a team assessment value + NoOfComment(s). See (4). The formula is shown below:

$$\text{Commitment/Disposition} = TA + NoOfComment(s) \quad (4)$$

Note that TA is Team Assessment. It is calculated as a total of a self report commitment/disposition value. There are pre- and post-questionnaires about how users feel toward the section in the given tasks, and how they feel about other group members. NoOfComment(s) is number of comments that a group member generates to other members during working period. If a group member generates more comments to others, he or she tends to have high commitment for accomplishing a group task.

This information endeavors to capture the feeling of a person toward other members, a particular content in the work space, and how much a person contributes to a group task using the number of comments in group work, which have been made, by the members in the same group.

B. Web-based GDSS

This paper presents group decision support system with group awareness information in a web-based environment called web-based GDSS. It is designed and implemented by following the Nominal Group Technique (NGT). This NGT technique is a structured decision making technique widely used both in industry and academia as a tool to aid in planning and decision-making processes [21]. Paulus' cognitive theory of group creativity suggests conditions under which cognitive stimulation can be observed in groups [21]. The theory suggests that sharing ideas within a group stimulates additional generation and association of ideas. The Nominal Group

Technique (NGT) provides an advantageous environment to stimulate creativity since it allows silent generation of ideas, which then are shared by the group. The technique has been recognized to equalize participation, tolerate conflicting ideas and stimulate the generation of ideas by sharing them with the group [22]. When groups generate ideas using brainstorming, the competing demands of generating their own ideas and also processing the ideas of the others has been observed to divide the participants' attention [21], [23]. Paulus and Yang [24] recognize that if after brainstorming, individuals are provided with an opportunity to generate additional ideas on their own; the impact of cognitive stimulation may become more evident. Nominal Group Technique seems to provide the appropriate environment for cognitive stimulation while encouraging creativity [22].

The NGT session in web-based GDSS consists of the following phases:

- Fill out a pre-session questionnaire
- Presentation of the task statement
- Idea generation
- Round robin (optional in this research)
- Clarification or evaluation of each idea
- Voting and ranking all ideas
- Final discussion (optional in this research)
- Fill out a post-session questionnaire

In the web-based GDSS, a script was created so that all sessions would be as consistent as possible. A web site was specifically designed to conduct the NGT group works through the computer (web browser). Process support for the participants was provided through the site by instantaneous instructions on each step of the process. The web site had three main features, a built-in pre-session questionnaire, working area session and tools (edit/ ranking pages, comment/ communication tools), and a built in post-session questionnaires. First, group members are directed to the pre-questionnaire when they enter the web site. Once the questionnaire is completed, they are directed into the second part, which is a working area session, starting with instructions for group work. After reading instructions carefully, they are asked to login their session with username and password. Next, the decision process begins with the idea generation phase. During this phase, they individually spend time with generating ideas to solve their tasks in the web page. After finishing idea generation phase, they are allowed to communicate with each other by using a chat room (interaction screen) provided for each group. They can ask and discuss with other members in the same group. They can collaborate or help each other to solve the given task and generate more ideas. Each group member can also use a comment tool for sending comments to other members in the same group. Next, all members have time to refine their task by working in their own session such as the option to clarify, reword, add or group the ideas if needed. During this phase, every member spends most of the time to improve their individual tasks. The chat room is not available in this phase. Then each member has to select their seven preferred ideas for being scored by the other team members in the same group. The total score of each listed idea for each member is calculated and uploaded to the web site. Finally,

they fill out the post-session questionnaire. Pre- and post session questionnaires are used to capture some dependent variables from individuals. Especially, some variables from pre- session questionnaires such as current life rating (CLR) and expected minute connected are obtained in order to generate availability information. A simplified scheme of the GDSS web site architecture is shown in figure 2.
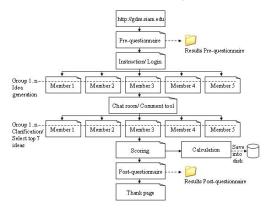

Figure 2. GDSS web wite architecture.

The members in the group that are allowed to see awareness information can see the visual display of group awareness information by clicking the link anytime during their work (see Figure 3). The working period for each session is specified in an instruction. Time limitation is assigned for each session.
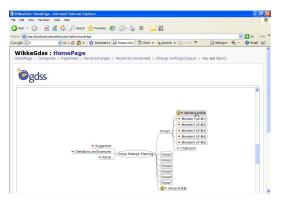

Figure 3. Member activity (group awareness information) link in web-based GDSS.

C. The Group Awareness Information as Visual Interface in Web-based GDSS

Given operational definitions, there are a variety of ways to present information. In the literature, Michael [19] presents the social awareness tool in CASCADE that shows the level of user activity, the current focus of their efforts, and their disposition to engagement. In their work, activity information is represented by the fuzziness of the image. Pictures of a user are sharp if the activity is high and fuzzy is activity is low. The resolution is relative to all members in a team for a particular document. Availability information is shown by a slide bar

with the indicator moved to the right indicating higher availability. Commitment/ Disposition information is depicted by color. Pictures of users will be green if the disposition value is positive and red if negative. The amount of red/green will be relative to all members in a team for a particular document. All kinds of information above are presented in real-time collaborative work on CASCADE. The findings in their study about awareness tools are contrary to the theory. Their study expected that the group with awareness tools could produce better quality for a group task. In fact, the awareness tools had a negative effect on their performance. Participants gave the comments at the end of the experiment that the design of awareness tool was difficult to understand. Furthermore, they reported that participants may not have felt attached to their pictures in the awareness tool. Because experimental protocol regulation prevented taking photographs of participants to post on the computer screen, all pictures in the awareness tool were neutral and looked the same. It may even be the case that functional uses of the simpler awareness tools would lead to a better performance in group tasks.

Their results are brought into our study for improving visual display and finding out the ways to better represent these kinds of awareness information. Given a desire to code the group awareness information, a minimalist visual display is chosen. Using small smiley icons with short explanation are considered. Small smiley icons are chosen because people are familiar and using icons plus short term people can understand them easily. The visual display of group awareness information in web-based GDSS is shown in Figure 4.
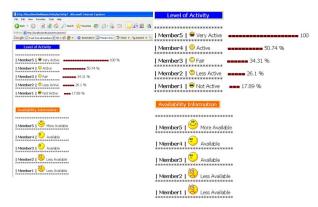

Figure 4. The Visual Display of Group Awareness Information in Web-Based GDSS.

V. CONCLUSION AND FUTURE WORK

This paper presents the design and implementation of the design and implementation of the visual display of group awareness information in web-based group decision support system. The group awareness information consists of three important factors: activity, availability, and commitment/ disposition information. The mathematical formula of each factor is defined and presented in session 4.1. A simplified scheme of the GDSS web site architecture is presented in session 4.2. The visual interface of group awareness information in Web-based GDSS is presented in session 4.3. The group awareness information is an important part for the

group members to generate more ideas, produce higher quality of the given task, produce a higher number of communications among members, and increase cohesiveness among team members.

Our future work will focus on the experimental settings. A controlled laboratory experiment will be undertaken to examine the effects of the use of a web-based group decision making technique with and without group awareness information. The main interest of next study is to analyze the perceived levels and to find out the relationships among variables. The study needs the answers for the following questions: 1) Do users/decision makers achieve higher quality for a given task in web-based GDSS with group awareness information than they do without group awareness information? 2) Does group awareness information effect group decision making by the members in the same group? 3) Does group awareness information effect the members in different groups in the sense of effecting each other's activities in the same given task? 4) Does member/decision maker produce a higher number of communications in web-based GDSS with group awareness information than they do without group awareness information? and 5) Do users/decision makers achieve higher cohesiveness among team members in web-based GDSS with group awareness information than they do without group awareness information? All members' feedback will be used to improve overall performance of the system.

REFERENCES

[1] Beaudouin-Lafon, M. (1994). Beyond the workstation: Mediaspaces and augmented reality. In G. Cockton, S. W. Draper, & G. R. S. Weir (Eds.), Proceedings HCI'94, (pp. 9-18). Cambridge:University Press.

[2] Ellis, C. A., Gibbs, S. J., & Rein G.L. (1991). Groupware - some issues and experiences. Communications of the ACM, January, 1991, 34(1), 38-58.

[3] Brown, J. S., & Duguid, P. (1994). Borderline Issue: Social and material aspects of design. Journal of Human-Computer Interaction, 9(1), 3-36.

[4] Tatar, D., Foster, G., & Bobrow, D. (1991). Design for conversation: Lessons from Cognotor, IJMMS 34, 2, 185-209.

[5] Moran, T. P., & Anderson, R. J. (1990). The workday world as a paradigm for CSCW. CSCW'90, Proceedings of the Conference on Computer Supported Cooperative Work, Los Angeles, California, 1990, 381-393.

[6] McGrath, J. (1984). Groups: Interaction and performance. New Jersey: Prentice-Hall, Englewood Cliffs.

[7] DeSanctis, G., & Gallupe, B. (1984). Information system support for group decision making (Working paper MISRC-WP-85-10). Minneapolis: Management Information Systems Research Center, Graduate School of Management, University of Minnesota.

[8] D.J. Power, S. Kaparthi, Building Web-based decision support systems, Studies in Informatics and Control 11 (4) (2002) 291– 302.

[9] Dourish, P., & Bellotti, V. (1992). Awareness and coordination in shared workspaces. CSCW '92. Conference proceedings on computer supported cooperative work, October 31 – November 4, Toronto, Canada (pp. 107-114).

[10] Greenberg, S., & Johnson, B. (1997). Studying awareness in contact facilitation. Position paper for the ACM CHI '97 workshop in collaborative systems, organized by Susan E. McDaniel and Tom Brinck, Atlanta, GA, March 22-27.

[11] Gutwin, C., & Greenberg, S. (1997). Workspace Awareness. Position paper for the ACM CHI'97 workshop in collaborative systems, organized by Susan E. McDaniel and Tom Brinck, Atlanta, Georgia, March 22-27.

[12] Gutwin, C., Stark, G., & Greenberg, S. (1995). Support for workspace awareness in educational groupware. CSCL'95 Proceedings, September 1995, pp.1-8.

[13] Gutwin, C., Roseman, M., & Greenberg, S. (1996). A usability study of awareness widgets in a shared workspace groupware system. CSCW' 96, Proceedings of the ACM 1996 conference on computerr supported cooperative work, November 16-20, 1996, Boston, Maassachusetts, USA, 258-267.

[14] Endsley, M. R. (1995). Toward a theory of situation awareness in Dynamic systems. Human Factors, 37(1), 32-64.

[15] Borning, A., & Travers, M. (1991). Two approaches to casual interaction over computer and video networks. CHI' 91. Human factors iin computing systems conference proceedings on reading through technology, April 27-May 2, 1991, New Orleans, LA, 13-19.

[16] Buxton, W. (1993). Telepresence: Integrating shared task and person spaces. In R. M. Baecker (Ed.), Readings in groupware and computer-supported cooperative work (pp. 816-822). San Mateo, CA: Morgan Kaufmann.

[17] Ishii, H., & Kobayashi, M. (1992). ClearBoard: A Seamless Medium for shared drawing and conversation with eye contact. CHI'92. Conference proceedings on human factors in computing systems, May 3-7, 1992, Monterey, CA, 525-532.

[18] Dourish, P., & Bly S. (1992). Portholes: Supporting awareness in a distributed work group. CHI'92. Conference proceedings on human factors in computing systems, May 3-7,1992, Monterey, CA, 541-547.

[19] Michael B. Spring & Vichita Vathanophas (2003). Peripheral social awareness information in collaborative work. Journal of the American Society for Information Science and Technology, 54(11):1006-1013, 2003.

[20] Pilar Pazos Lago, et al., (2006). Structuring group decision making in a web-based environment by using the nominal group technique. Computer & Industrial Engineering 52, pp. 277-295.

[21] Paulus, P. B., Larey, T. S., & Dzindolet, M. T. (2000). Creativity in groups and teams. In M. Turner (Ed.), Groups at work: Advances in theory and research (pp. 319-338). Hillsdale, NJ:Hampston.

[22] Delbecq, A. L., Ven, A. H., & Gustafson, D.H.(1975). Group techniques for program planning: A guide to nominal group technique and delphi processes. Glenview, IL:Scott-Foresman & Co.

[23] Mulligan, N. W., & Hartman, M. (1996). Divided attention and indirect memory tests. Memory & Cognition, 24, 453-465.

[24] Paulus, P. B., & Yang, H. (2000). Idea generation on groups: A basis for creativity in organizations. Organizational behavior and human decision processes, 82(1), 76-78.