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Computer-Mediated Communication and Innovation: Do Communication Media Properties Influence Innovative Thinking Processes?

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ABSTRACT

This paper concerns potential impacts that characteristics of communication media in computer-mediated problem solving in groups have on group-members' innovative thinking. Different processes involved in effective idea generation and problem solving are presented, and we discuss how three characteristics of communication media relevant for group collaboration aiming at producing innovative ideas might influence the group process. A research model is presented, and hypotheses regarding the effects of affordances on innovative thinking are put forth. We finally describe a possible methodological approach that might be applied in order to test the proposed hypotheses.

Key words: CMC, Computer-mediated communication, Innovative thinking, Problem solving, Idea generation.

1. INTRODUCTION

Superior performance in product development and innovation is believed to be one of the main sources of competitive advantage in the modern market place, and information technology used to facilitate innovative and creative processes is used in a variety of organizational settings. In this business environment, where innovation processes are facilitated by computer-mediated communication, it is important to obtain knowledge of *whether (and in case how) qualities or properties of electronic communication media influence individuals' innovative thinking in group-based problem solving*. This research question is addressed in this paper.

Many studies in the computer-mediated communication (CMC) literature focus on differences between various "communication modes" (e.g. face-to-face and dispersed CMC), without digging deeper into the underlying qualities of the modes. However, in order to generate new knowledge on desirable use of ICT in groups, it is important to investigate how the distinctive characters of different CMC settings impact on relevant dependent variables. We will therefore put emphasis on variables that all mediated and non-mediated communication processes can be described and evaluated by in this paper. There are many theories that have been developed in this research stream, and accordingly there are many theoretical concepts describing underlying features of communication modes. Theories like Media Richness Theory [12], Media Synchronicity Theory [14] and Burgoon et al.'s [6,7] interactivity model all make efforts in describing the constituent parts of mediated communication. Based on these contributions, we discuss media properties that may be of particular importance for innovation processes in group-based problem solving. In studies occupied with the relationship between use of ICT in group interaction and innovation, the dependent (innovation) variables investigated are most often the products or artifacts resulting from the group processes. Variables often found in this research domain are for example the number and quality of the ideas generated [e.g. 10]. Accordingly, little emphasis has been put on how communication media characteristics influence the *processes* which lead to better or more desirable scores on the before mentioned outcome variables. This research applies such a process perspective, and focus on innovative thinking processes for each individual in a group-based problem solving situation. The paper is organized as follows: We first present and discuss the theoretical constructs that are relevant for our study, then we present the research model and our hypotheses. In the final part we present a potential methodological approach for testing the hypothesized relationships.

2. THEORY

2.1 Innovative Thinking in Idea Generation

Innovation can be understood as a process of creating or modifying an idea and developing it to produce products, services, processes, structures, or policies that are new to the organization [24]. The phases in the innovation process are conceived to encompass the generation, development, and implementation of new ideas and behaviors [5]. This conceptualization of innovation is highly related to *organizational creativity*, which can be defined as "the creation of a valuable, useful new product, service, idea, procedure, or process by individuals working together in a complex social system" [23 p. 293]. Both innovation and organizational creativity are initiated with idea generation, and successful outcome of this phase is related to certain thinking processes. The concept of *thinking* is often construed as "an umbrella term for a range of *processes* associated with *"high-level" cognition*, such as reasoning, categorization, and judgment and decision making" [17 p. 266, our italics]. In a problem solving situation, the first process that

needs to be initiated is a search for alternatives. That means that the decision makers or problem solvers have to collect information that is relevant to the problem, and which may contribute to, or are necessary for, a successful change. After the search for alternatives, the decision makers need to select one specific solution that they find most appropriate for the task they face. There exists little controversy regarding the importance of these two "opposite" phases to be present in idea generation activities; in other words, successful completion of idea generation entails a combination of *divergent* and *convergent* thinking.

2.1.1 The Roles of Divergent and Convergent Thinking in Idea Generation

In a problem solving context, exercising divergent thinking involves starting with a specific problem and generating various options and perspectives on the problem. Convergent thinking follows the divergent process, and acts to narrow down the options available to obtain a number of "satisfying" solutions to the problem (figure 1).

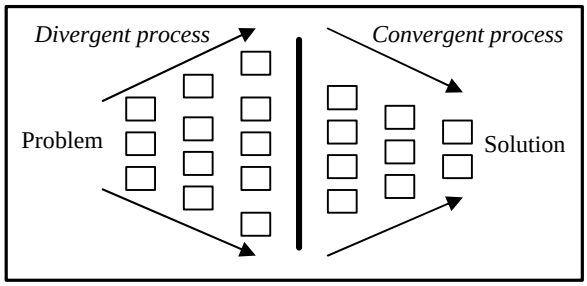

Figure 1: Divergent and convergent thinking

In this context, divergent thinking refers to going off in new directions rather than thinking solely on one solution, and deriving a variety of ideas from given information. Following divergent thinking, the ideas and information will be organized using convergent thinking; i.e., putting the various ideas back together in some organized, structured way. Some authors advocate the deliberate distinction between divergent and convergent thinking processes. Belonging to this school of thought, Basadur et al. [4] identified a sequenced two-step thinking process called "ideation-evaluation". They defined "ideation" as the production of ideas without evaluation, and "evaluation" as the application of judgment to the ideas produced. One of the reasons for making a clear distinction between these processes is to avoid that people hold back ideas they think are stupid or silly, and by this using divergent and convergent thinking interchangeably. To create significant improvements or entirely new products, services or processes, those ideas that seem absolutely preposterous or unachievable at first are needed. Empirical research has supported both the general separation of idea production from idea selection and the more specific ideation-evaluation process [1,3,4].

Basadur and Finkbeiner [3] view ideation as having both *cognitive* and *attitudinal* elements. Effective ideation may thus "require specific attitudes favoring this kind of thinking, perhaps to help participants truly "let loose" and use more fully their unencumbered imaginations" (p. 38). Such attitudes may for example impact on decisions of whether ideas that are produced should be put forth, and are therefore important aspects of the idea generation process. This is consistent with several "general" theories concerning the linkage between attitudes and behavior, like Kraut's [18] training model suggesting a causal chain whereby attitude change leads to performance change, and Fishbein and Azjen's [15] theory of reasoned action proposing that behavior can be predicted by individual attitudes and social norms.

2.1.2 Attitudes Toward Idea Generation

According to Basadur et al. [4] and Basadur and Finkbeiner [3], persons have attitudes toward both ideation and evaluation, and they have identified several *attitudinal constructs* related to idea generation. Two of these constructs are "preference for ideation" and "tendency for premature critical evaluation of ideas". The denotation of the first construct concerns mind-sets such as "being less likely to jump to conclusions as to what is the real problem", and "more open-minded to new ideas and approaches [2 p. 22], while the mind-sets associated with the latter construct are more or less opposite[1]. Basadur and Finkbeiner developed internally valid and reliable measures of these constructs, which we will adopt in our study.

2.2 Communication Media: Capabilities

Many theories have been developed to categorize media qualities and explain media effects on communication outcomes [e.g. 16]. One of the most widely used media categorization theories is *Media Richness Theory* [12], which suggests that communication media can be ranked on a richness-leanness continuum, and asserts that task performance will be improved when tasks' information needs are matched to a medium's richness or it's capabilities to facilitate shared meaning. Empirical tests have not been very supportive, however, particularly for new communication media [e.g. 8, 13]. Recognizing the weaknesses of Media Richness Theory, Dennis and Valacich [13] introduced *Media Synchronicity Theory*, which suggest that media have five capabilities that are important in understanding the effects of media use on the ability to communicate and process information; 1) immediacy of feedback, 2) symbol variety, 3)

[1] As "tendency for premature critical evaluation of ideas" is more or less antagonistic to "preference for ideation", we use the term "preference for evaluation" for this particular attitude.

parallelism, 4) rehearsability, and 5) reprocessability. Both media richness theory and media synchronicity theory categorize media attributes in terms of what kind of properties or capabilities the different media possess. Following this kind of reasoning, Burgoon et al. [6,7] suggest two ways of characterizing the *interactivity* concept often used in discussions of CMC. First, it can be considered in terms of the structural properties of the medium, or second, by qualitative experiences as perceived by the user. Regarding the first categorization type, Burgoon et al. integrate the various analysis of media affordances into an extensive set of properties, consisting of: *1) participation* (extent of engagement in the interaction), *2) mediation* (whether the interaction is mediated or not), *3) contingency* (extent to which contributions are dependent on prior postings), *4) media and information richness* (whether the format utilizes one or more modalities, and the extent to which it supports symbol variety), *5) geographical propinquity* (physically co-located or distributed participants), *6) synchronicity* (same-time or asynchronous interaction), *7) identification* (fully identified, partially identified or anonymous participants), *8) parallelism* (whether the format permits concurrent communication and multiple addressees, or only permits serial messages), and *9) anthropomorphism* (extent to which the system interface simulates or incorporates humanlike characteristics). Communication media can thus be described and evaluated in terms of their abilities to enable specific aspects or properties of the communication process. In other words, all communication processes can be characterized by certain *affordances*, and communication media differ in their capabilities to support and enable these affordances. We will place emphasis on three affordances that may influence attitudes toward idea generation: "synchronicity", "parallelism", and "identification".

2.2.1 Synchronicity

Synchronicity refers to whether the interaction is same-time or not. A high level of synchronicity enables the interacting parties to give immediate feedback, which refers to the extent to which a medium enables users to give rapid responses to the communications they receive [12]. Opportunity for rapid bidirectional communication has been shown to affect communication outcomes by increasing interaction between the parties, allowing rapid assessment and modification of the message [25]. We thus define synchronicity as "the extent to which the participants engaged in a problem solving situation can give immediate feedback to the postings of other group members, and receive immediate feedback on their own postings from other group members". We are concerned with the level of synchronicity *as perceived by the participants* in a group problem solving situation (as people may have different perceptions of the same technology). The highest level of synchronicity is most likely to occur when interaction takes place in real time, and the level will decrease along with increasing time lag between messages from one participant and responses to these messages from another participant. It is important to emphasize that a high level of synchronicity does not assure immediate feedback; it is rather related to the *opportunities* that the participants have for giving rapid responses to the messages of others. Low synchronicity thus implies that the participants involved in interaction do not have the opportunity to give and receive immediate feedback.

2.2.2 Parallelism

Many electronic media can be structured to enable multiple interacting parties in one session, and parallelism refers to the number of simultaneous conversations that can *effectively* take place. High parallelism can increase the amount of information that can be simultaneously transmitted and received, but it can also decrease the effectiveness of information processing as it may lead to information overload. We define parallelism as "the participants' opportunities to be engaged in simultaneous dialogues in a group problem solving situation". High parallelism thus gives the participants opportunities to be engaged in multiple dialogues at the same time, and therefore they do not have to take turns in utterance of contributions. Low parallelism, on the other hand, means that all participants have to be engaged in a single dialogue, implying that only one member of the group can utter his/her ideas and comments at the same time. We are also for this affordance concerned with the levels as perceived by the participants in a group problem solving situation.

2.2.3 Identification

Individuals involved with idea generation may be influenced by the presence of others. Persons are concerned about how others perceive their ideas [10, 19,20], and depending on this evaluation apprehension, embedding idea generation in a group setting could either enhance or reduce an individual's contribution of ideas. On the positive side, the group might provide encouragement, stimulation or reward for creative contributions, and on the negative side, contributors might anticipate embarrassment, hostile evaluation, conformity pressures or other punishments for proposing unusual ideas [9]. Several authors have identified the anonymity option as a particular virtue of Group Decision Support Systems in that anonymity encourages full participation of group members that otherwise would have been socially inhibited from expressing unpopular, novel or heretical opinions [21]. We define identification as "the extent to which the contributor of ideas, comments, etc. in a group problem solving situation is known by the other participants". Similar to the other affordances, we are also in this

case interested in the level of identification as perceived by the participants.

Based on the theoretical review, we propose a research model that consists of "synchronicity", "parallelism", and "identification" as the independent variables, and "preference for ideation" and "preference for evaluation" as the dependent variables (figure 2).

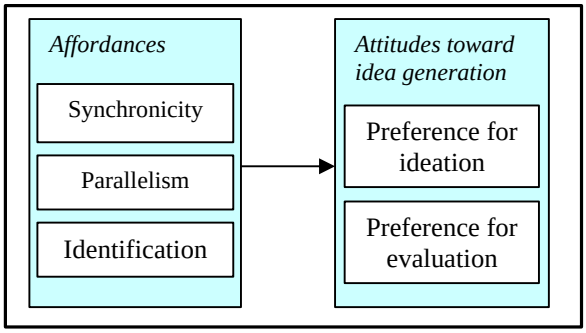

Figure 2: Research model

3. HYPOTHESES

3.1 Effects of affordances on attitudes toward idea generation

Information and communication technologies differ in their abilities to support affordances of the communication process, and synchronicity, parallelism, and identification may contribute differently to innovative thinking. We therefore expect that affordances will have different effects on attitudes toward idea generation.

3.1.1 Synchronicity

Feedback is a powerful tool for innovation processes, and it is important to emphasize the role of immediacy of feedback (timing) as a particular collaboration characteristic in idea generation. That is, timing of feedback is important in order to avoid a situation where evaluation stifles innovation before it has a chance to develop. While there are many different methodologies about how to most effectively engage in idea generating activities, one element that they have in common is that the free flow of initial ideas must occur without the interruptions of criticisms or evaluations. Low synchronicity enables both rehearsability and reprocessability, which may be regarded as "evaluative activities". High synchronicity on the other hand, does not render possible a critical examination of neither the ideas that the sender is to put forth (rehearsability), nor the ideas or messages that an individual has received from other participants (reprocessability) before composing a response. Thus, interaction in same-time, although enabling interruption and immediate critical feedback, may have positive impacts on ideation. On this basis, the following hypothesis is put forth:

H1: High degree of synchronicity correlates positively with "preference for ideation", and low degree of synchronicity correlates positively with "preference for evaluation".

3.1.2 Parallelism

According to Van de Ven et al. [22], an increase in the number of initiatives undertaken by a large number of interacting people enhances the probability of stimulating innovation. With reference to the distinction between ideation and evaluation, one aspect that support the assertion put forward by Van de Ven et al., is that high degree of parallelism makes it difficult to reprocess ideas that have been put forth, while at the same time being attentive to the ongoing discussion. Hence, there is no room for a comprehensive critical evaluation of all ideas that are posed. Another important aspect of parallelism regarding idea generation, which may be a consequence of the absence of opportunities for critical evaluation as discussed above, is that it can create an environment of interaction and discussion that facilitates hitchhiking. However, there will not be an exponential increase in hitchhiking effects with increasing parallelism. The reason for this is that individuals cognitive capacities are limited, thus there may be a problem of information overload if the number of participants exceeds a certain limit. Conversely, low (or absence of) parallelism will probably result in more (and critical) rehearsability of the ideas that the participants are to suggest. In these cases, the participants are aware of that they have the other participants' full attention when contributing their ideas, and are thus likely to be more self-critical when communicating. The following hypothesis may be stated:

H2: High degree of parallelism correlates positively with "preference for ideation" and low degree of parallelism correlates positively with "preference for evaluation".

3.1.3 Identification

Participants in joint idea generating tasks are influenced by each other. This is particularly relevant when it comes to the participants' decisions of whether or not to contribute and express their ideas. Most individuals are concerned about how others perceive and think of them, and can therefore be reluctant to express unorthodox or non-conforming ideas. Working in a group where the identities of the participants are known might inhibit a contributor who anticipates embarrassment, hostile evaluation, conformity pressures, or other punishments for proposing unusual ideas. In contrast, anonymity may lead to a reduction of these mechanisms. That is, it is reasonable to believe that the fear of getting negative comments will be lower if the interacting parties do not know the identity of each other. In other words, the barriers related to

idea expression that people experience, will be lower if the proposals can be done anonymously. Thus:
H3: Unknown identities (anonymity) correlate positively with "preference for ideation" and known identities correlate positively with "preference for evaluation".

4. METHOD

The focus of the study is on whether/how communication media influence individuals' innovative thinking processes within group settings. Thus there are three "key components" that the methodology must be based on in order to answer the research question: 1) The setting must involve group collaboration, 2) the participants must be involved in a joint problem solving situation, where the focus is placed on the participants' thinking processes, and 3) they must interact by use of electronic media (collaborative software / tools).

4.1 Research Design

The design of the study must ensure that the measurement of the variables is adequate, and that the variance of affordances is sufficient for hypotheses testing. Further, when hypotheses suggesting a correlation between variables are posited, the research design must control for alternative explanations. In such situations, internal validity must be given priority [11], and an experimental design is therefore preferable. Subjects participating in the experiments will be randomly distributed into groups that will be given tasks which necessitate CMC between the members in order to be accomplished. Within the experimental groups, the affordances will be manipulated, and attitudes toward idea generation will be measured on an individual level. Each group will consist of 3-5 participants, and 2 groups will be needed for determining the effects of each affordance. As the objective of this study is to investigate the effects of specific affordances on attitudes toward idea generation, and not on revealing differences in effects of non-mediated versus electronically mediated interaction on these attitudes, we find it unnecessary to include FtF interaction as an experimental condition in the study. The design we will apply is illustrated in figure 3. When focusing on synchronicity, we compare the aggregate synchronicity-score in groups 2 and 3

	Group 1	**Group 2**	**Group 3**
Synchronicity	Low	High	
Parallelism	High	Low	High
Identification	Identified		Anonymous

Figure 3: Experimental design

with the synchronicity-score in group 1. The same process is done for the other affordances as well (groups 1 and 3 versus group 2 for parallelism, and groups 1 and 2 versus group 3 for identification).

4.2 Tool kit and manipulation of affordances

The experimental conditions represent our manipulations of the independent variables. We will use specific Internet-based software for group collaboration (Groove 2.5), which has a set of basic functions that form the basis for the interaction between group members. For all experimental groups, the technology will be based on the same "framework", with the exception of the specific configuration that is needed in order to provide for variation of affordances. In the next sections we describe how the variables will be manipulated.

Based on the definition of synchronicity proposed in section 2.2.1, we operationalize this variable as *the time that elapses from the messages of one participant are posted to these messages are received by another participant.* For groups 2 and 3, we will ensure (perceived) high synchronicity by letting the participants work online. By using the shared space in an online condition, all participants in a group will have the same user interface, meaning that the contributions of one participant will pop up immediately on the other participants' computer screens. In contrast, the participants in group 1 will work offline. During the one problem solving task, the participants will log into the shared group space every three minutes (one problem solving task lasts for 30 minutes). These online periods will be as short as possible, only enabling the work space to be updated.

The operational definition of parallelism we will use is as follows: *The degree to which it is possible for the participants to post their ideas and comments at the same time without interrupting others*. In the shared work spaces of groups 1 and 3, the level of parallelism should be high. Implementing this characteristic means that all participants in the groups will be able to post their contributions simultaneously without interrupting others. Conversely, the contributions of the participants in group 2 must be posted one at a time in order to avoid interruption of others. It is worth notice, however, that the collaborative software does allow for simultaneous postings in the same window, but this type of interaction will not be efficient (this will be the same as when people speak all at once in an FtF setting).

Based on the definition of identification proposed in section 2.2.3, this variable is operationalized as *whether or not the identities of the participants in a group problem solving situation are displayed along with (and thus linked to) the contributions of the participants*. In order to ensure *perceived identification*, the names of the contributors will be displayed together with their postings, meaning that the contributions can

be identified. The identities of the participants (both online and offline) in the shared space are also shown in a "list of participants". Contrary, in group 3, the identity of the participants will not be displayed together with their contributions and feedback, and the participants will not know the identities of the other group members.

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