Social Networks and Communication Media for Generating Creative Ideas

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Abstract. Why some dyadic interactions are more likely than others to trigger hinder the generation of novel and useful ideas? To investigate this question, we examine the attributes of dyadic ties that influence the generation of creative ideas, and how the strength of influence changes contingently on the mix use of communication media. Our study extends previous research by examining the impacts of Simmelian advice tie, Simmelian friendship tie and communication media mix on generating creative ideas. We conducted a survey among students in a knowledge-intensive academic institution. The results show that Simmelian advice tie, Simmelian friendship tie and communication media mix help to trigger the generation of creative ideas. The impact of Simmelian advice tie on creative idea generation is weakened by communication media mix, while the influence of Simmelian friendship tie is strengthened by it. We discuss both theoretical and practical contributions of our research on these findings.

Keywords: generating creative ideas, Simmelian advice tie, Simmelian friendship tie, communication media mix

1 Introduction

Creativity refers to the generation of ideas that are novel and useful [3]. It is important to study creativity in order to effectively manage the innovation process in organizations. It is even more important to understand how to generate creative ideas because idea generation is the prerequisite for idea evaluation and selection [16]. Generating creative ideas has been studied from different perspectives, including organizational [e.g., 27] and individual [e.g., 31] levels. However, little attention has been devoted to studying creativity at the dyadic level, i.e., generating creative ideas between each pair of individuals. Dyadic exchanges are not only conduits of knowledge but also sources of social support [38]. This paper examines the attributes of dyadic ties that influence the generation of creative ideas; and how the strength of influence changes contingently on mix use of communication media.

A Simmelian tie refers to the extent to which a focal dyad is surrounded by at least one common third party [21]. Two types of ties commonly occur in organizations: tie between coworkers and tie between friends. Advice tie encourages task-oriented and

norm-supporting interactions to solve challenges that require novel and useful ideas [34]. On the other hand, friendship tie includes personal trust that provides comfortable opportunities to discuss uncertainties and concerns with peers to come out with creative thoughts [34]. However, there is little research looking at the impacts of the presence of third party on generating creative ideas in both advice and friendship networks. Research on absorptive capacity and associative learning has shown that it is easier to absorb diverse knowledge to generate creative ideas when individuals share a common knowledge base of similar third party [32]. Therefore, we initially explore that the existence of common third party around a focal tie substantially changes the nature of generating creative ideas.

Besides the influence of common third party presence in different networks, the mix use of communication media is another factor that would significantly impact on the process of generating creative ideas in dyads. Different media has been widely implied in organizational work, including face-to-face communication, mediated communication. Mediated communication refers to communication that takes place using communication technology (e.g., telephone, computer) [40]. On one hand, communication technology enables diverse groups of people to collaborate and make decisions, regardless of their geographic locations [23]. On the other hand, some research suggests that the potential for process losses exists when using mediated communication [15]. However, process losses that occur because of mediated communication challenges may actually be beneficial when the end result is a creative product.

Due to the knowledge gaps identified above, we address the following research questions in this study:

RQ1: How does Simmelian advice tie impact on generating creative ideas?

RQ2: How does Simmelian friendship tie impact on generating creative ideas?

RQ3: How does communication media mix moderate the impacts of Simmelian advice and friendship ties on generating creative ideas?

This research has significant theoretical contributions. It helps in understanding of how creative ideas are generated between individuals by integration of different theoretical perspective (i.e., Simmelian advice tie, Simmelian friendship tie and communication media mix). Through examining the direct and moderating effects of communication media mix, the research opens a black box to demonstrate how communication media influences the generation of creative ideas. More importantly, it calls for the need to devote significant theoretical attention to dyadic perspective in studies investigating the nuances of social networks in work teams.

The study also provides practical contributions. Organizational managers are often encouraged to form creative teams by structuring Simmelian ties in either advice or friendship network among employees. Organization workers could leverage both face-to-face and mediated communication to assist in generating creative ideas. Additionally, technology system designers can better understand how to integrate multiple technology artifacts (e.g., verbal and non-verbal cues) by considering specific communication tools with corresponding artifacts.

2 Theoretical Background

2.1 Creativity: Generate Creative Ideas

Generating creative ideas is often the result of novel combinations of different perspectives individuals are exposed to via social interactions [2]. Social interactions are defined as the transfer of information between the source which is sending information and the recipient who is receiving information [38]. Social interaction between two individuals includes the following basic stages: the recipient's acquiring of knowledge from the source and processing that knowledge, and then the realization of the potential value of the interaction outcome [32]. Processing knowledge that yields creative ideas has been the subject of studies that adopt a cognitive psychology perspective in studying creativity [37]. Within this context, creative ideas are associated with the occurrence of two distinct sets of cognitive processes: generation of creative ideas and evaluation of the generated ideas to select the ones for further pursuit. This model is consistent with the "blind-variation and selection-retention" model of creative thought by Simonton [37]. As the recipient evaluates the ideas after interacting with the source, that recipient is able to realize the novelty and usefulness of the ideas.

We rely on the recipient to assess the novelty and usefulness of his/her ideas because we focus on the generative aspect of ideas before the ideas are exposed for further evaluation. It is important to recognize that what the recipient considers as potentially creative may not necessarily be considered as creative by others.

2.2 Simmelian Ties for Generating Creative Ideas

In reality, a social tie between two individuals includes different relationships such as advice or friendship tie. Previous research suggests that supportive behavior on the part of others in a work-place (such as coworkers) enhances employees' creativity [29]. On the other hand, friendship tie considers with whom individuals share perceptions and rely for social support [12]. It includes personal trust that provides comfortable opportunities to discuss uncertainties and concerns with peers to come out with creative thoughts [34]. Particularly, Simmelian advice tie indicates whether a connection between two coworkers is Simmelian or not; meanwhile; Simmelian friendship tie describes whether a friendship is Simmelian or not .

Generating creative ideas requires individuals to hold common knowledge and shared understanding to derive personal thinking and solutions from a new perspective. We contend that Simmelian tie can enhance generating creative ideas. Simmel and Wolff [36] argued that network size does not fundamentally change the impact of a network on behavior, rather, the change from a dyad to a triad or a larger network changes an individual's behavior. Simmelian tie facilitates the formation of shared understanding and the pursuit of common goals by mitigating competition and self-interest. This is important, because informational advantages can be quite limited if the parties involved, acting opportunistically, avoid sharing sensitive [41].

A distinction between a Simmelian tie and a non-Simmelian tie may provide novel insights into how individuals leverage common knowledge and shared understanding to generate creative ideas from a new perspective. Simmelian advice tie increases the stability of interaction to achieve the successful integration of different perspectives to generate creative ideas [9]. Meanwhile Simmelian friendship tie enhances the generation of creative ideas by improving open communication to foster a collaborative environment [28].

2.3 Communication Media for Generating Creative Ideas

Compensatory adaptation theory (CAT) is based on the idea that human brains are initially designed for face-to-face communication [20]. Users of mediated communication exerted greater cognitive effort and experienced more communication ambiguity than dyad engaging in face-to-face communication. Regardless of the problems and challenges that have been associated with mediated communication, the ambiguous communications or inaccurate communication fluency that results from it actually leads to increase in creativity [40]. Creative solutions to problems have sometimes developed as the result of accidents or misunderstandings. Moreover, studies in cognitive psychology have shown that when individuals do not have all the information they need to make a conclusion, they "fill in the blanks" based on their individual knowledge base [20].

As recipients of information do not spend significantly more time compensating for the obstacles presented by mediated communication, they have more time to interpret presented information and combine it with existing knowledge which may help in the development of creative ideas. Since too many social and nonverbal cues may provide irrelevant information and interfere with message content, too much face-to-face communication (as a rich medium) may be detrimental to generate creative ideas [44]. Thus, the value of applying CAT to generate creative ideas is that the ambiguity and lack of communication fluency inherent in the move away from continual face-to-face interactions provides individuals with opportunities to perceive information in ways different than that in which it was intended.

A second main theoretical perspective we draw upon to understand the relationship between communication media use and generating creative ideas is dual coding theory. Dual coding theory (DCT) posits that individuals learn and retain information through both verbal and nonverbal systems [11]. In reality, individuals present and receive information in multiple ways; the use of multiple media allows us to process different facets of information in a variety of ways [25]. Thus, receiving information through mediated media and in face-to-face situations not only influences how one receives information but affects how one perceived information and influences the amount of time one engages in communication-related activities [40]. Use of non-face-to-face communication media provides individuals more time to ponder the information contained in a mediated interaction [14]. Thus, DCT would suggest that because generating creative ideas requires that an individual eventually bring divergent ideas together, have a mix of mediated communication and face-to-face interactions is important.

3 Research Model and Hypotheses Development

3.1 Effect of Simmelian Advice Tie

The increased stability promotes the formation of a common knowledge among the coworkers involved at work [41]; common knowledge is critical to overcome interpretive barriers and achieving the successful integration of different perspectives to generate creative ideas [9]. Another element that differentiates Simmelian advice tie from non-Simmelian advice tie is the higher level of cooperation observed within the dyads at work [41], regard of norms of reciprocity that facilitate advice exchanging for solving problem [32]. Cooperation becomes a shared value in densely connected structures, and individuals with common-third coworker(s) are naturally inclined to devote time to knowledge sharing with others. When a dyad shares common-third coworker(s) that strengthens the collaborative environment around them, it improves the conditions to generate creative ideas between the dyads [12, 28]. Therefore, we hypothesize:

H1: The presence of Simmelian advice tie is positively associated with the generation of creative ideas between dyads.

3.2 Effect of Simmelian Friendship Tie

Strong friendship tie influences shared values [18], and such shared value can induce the common knowledge to trigger generating creative ideas between individuals. As well, friendship enhances open communication [19], due to the emotional attachment [6] that is intrinsic to the relation. These factors are associated with the fostering of a collaborative environment favorable to creativity [28]. As well, the presence of common-third friend(s) can foster trust of the interacting individuals to engage more closely at work, which could form the collaborative conditions needed to generate creative ideas [28]. Therefore, we hypothesize:

H2: The presence of Simmelian friendship tie is positively associated with the generation of creative ideas between dyads.

3.3 Effects of Communication Media Mix

Researchers have found that communication tools can provide an environment conducive for sharing new and novel ideas. Too many social and nonverbal cues found in face-to-face communication (as a rich medium) may provide irrelevant information, distract from the task at hand, and be detrimental to creativity [44]. In contrast, a mediated communication environment is conducive to creativity because it prevents distraction from face-to-face communication. The intent of communication media mix is to determine how often individuals engage in mediated communications (e.g., email, Google Documents) relative to face-to-face interactions. According to dual coding theory, humans process information differently when it arrives in diverse forms [30]; thus, it is important to use more than one form of communication. When

multiple communication media are used, the total amount of possible communication activity expands, allowing all participants more air time. The increase in possible communication combined with the potential to generate creative ideas to arise from mediated communication ambiguity, suggest that more mediated communication is better for generating creative ideas. Therefore, we hypothesize:

H3: The degree of communication media mix is positively associated with the generation of creative ideas between dyads.

Simmelian advice tie is strong relationship, according to the definition of Simmilian tie [21]. Results from the network studies suggested that strongly connected coworkers prefer to stick on group-wide media; and at onsite teamwork, the most frequency media is face-to-face communication. Communication media choices influence how individuals interact, the type of information conveyed, and the amount of information conveyed in teamwork [25]. Interaction in teamwork in non-face-to-face communication is less likely than those who in face-to-face communication to exchange private and relational information [26]. This decrease in the amount and type of information shared may hinder the ability of individuals to generate creative ideas, as knowledge diversity is useful to generate creative ideas [38]. As CAT proposes, it is important to see visual cues when explaining something novel using language to be better able to share in face-to-face communication. Thus, individuals who are better able to understand and clarify others ideas in teamwork will be more likely to generate creative ideas. This will be more likely to occur in face-to-face communication. Hence, we hypothesize:

H4: The impact of Simmelian advice tie on the generation of creative ideas will be weakened by the degree of communication media mix.

Simmelian friendship tie indicates close friendship [21]. Close friends are less comfortable when expressing views that are different from others. This discomfort may be lessened when communicating in ways that do not highlight differences, such as in a computer-mediated environment where the recipient and source do not see each other [10]. Additionally, friends can rely on multiple communication media to interact with each other, due to the geographic and time issues. DCT suggests that use of different forms of communication media would help individuals develop and express creative ideas [30]. Therefore, we hypothesize:

H5: The impact of Simmelian friendship tie on the generation of creative ideas will be strengthened by the degree of communication media mix.

The theoretical propositions are summarized in figure 1. Next, we present a detailed description of the mechanisms of our design, which will be used to examine our research questions.

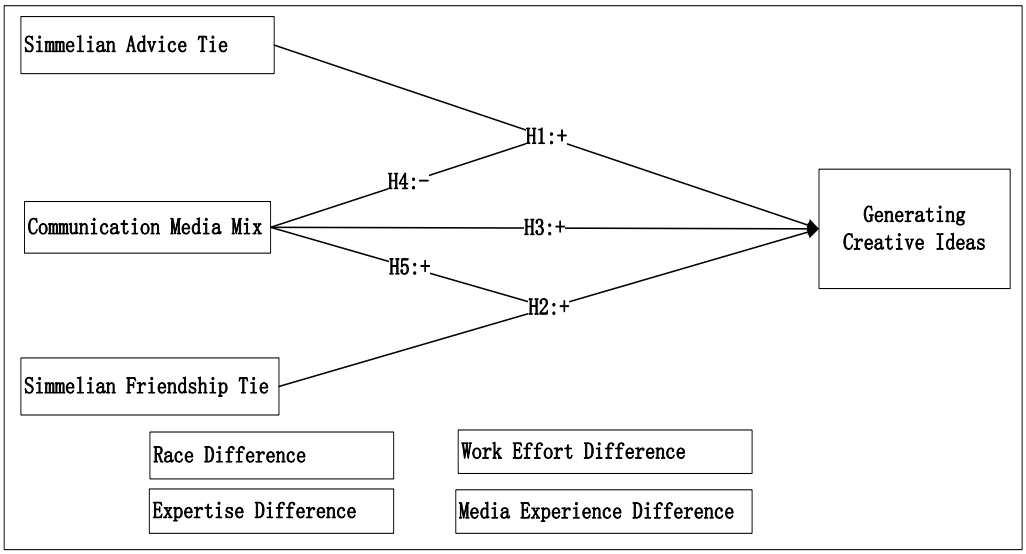

Fig. 1. Research Model

4 Methodology

4.1 Research Setting

The study, which involved knowledge-intensive teamwork, was conducted in a university course from an academic institution. The students participated in teamwork. Preliminary interviews with the instructors, observation, and existing documentation of the course confirmed that the teamwork would suffer from a lack of creative ideas. Since students were not constantly in physical contact, but frequently communicated with each other, it was important for them to have access to multiple communication tools.

Network data was collected using a combination of classical sociometric techniques [43] in a paper-based questionnaire. First, each student was provided with a fixed roster of contacts formed by the 79 students in the study. Students were asked to select those they had "gone to" for interactions that significantly affected their teamwork. The name generator used an "information seeking" perspective to ensure consistency throughout the survey because all the relational questions would be formulated from the recipient's viewpoint. This approach did not appear to lead respondents to omit a significant number of less important ties.

Responses were received from 72 of 79 students, resulting in a 91.14% response rate, which was more than the minimum 80% participation rate needed for network studies [33]. Demographic data was collected from their class rosters. The sample included a heterogeneous mix of educational backgrounds, including students from computer science (20%), information systems (35%), social science (10%), business (20%) and engineering (15%) departments. 53% percent of them were males.

4.2 Measurements

This study utilized single-item measurements to capture network variables. The combination of roster methodology and single-item measures is found to be mainly reliable [24].

Ease of generating creative ideas captures the extent to which it is easy for each pair of individuals to generate creative ideas associated with their interactions [38]. Instead of evaluating the number of creative ideas, we focused on the source's ease of generating creative ideas with the recipient. This measurement is consistent with previous studies on knowledge transfer at the dyadic level, which relies on the source of the dyad to assess the ease of transferring knowledge to the recipient [32]. The variables was captured by asking each respondent to rate, on a four-point Likert scale ("strongly disagree", "disagree", "agree" and "strongly agree"), his/her level of agreement with statements such as: "When I interact with this person, it is easy for me to generate novel and useful ideas." [38].

Advice and friendship ties. To measure advice tie, respondents were asked to indicate their advice exchange frequency on work-related issues with the identified source on a 4-point scale ("never", "less than once weekly", "once weekly", and "several times weekly") [42]. To obtain matrix of advice network (**A**), we code $\mathbf{A_{ij}}$ as "1" in case that actor *i* at least exchange with actor *j* once a week, otherwise, we set $\mathbf{A_{ij}}$ as "0". This operation is consistent with previous researches [39]. To measure friendship tie, respondents were asked to indicate their average frequency of going out with each person for non-work activities on a 4-point scale ("never", "less than once weekly", "once weekly", and "several times weekly") [35]. Thus, we gained the matrix of friendship network (**F**). A reciprocated relation existed only if person *i* connected to person *j*, and vice versa. This gives us the raw advice matrix ($\mathbf{R^A}$) and friendship matrix ($\mathbf{R^F}$). A hypergraph matrix illustrating every instance in which a respondent was tied to every other respondent was derived from the raw dyadic matrix obtained from the survey. We then derived the Simmelian advice matrix ($\mathbf{A^S}$) and Simmelian friendship matrix ($\mathbf{F^S}$) [22].

Simmelian advice tie ($\mathbf{A^S}$). $\mathbf{A^S_{ij}}$ =1, indicating the advice tie between respondent *i* and respondent *j* is Simmelian. Otherwise, $\mathbf{A^S_{ij}}$ =0, meaning that respondent *i* and respondent *j* is not Simmelian-tied.

Simmelian friendship tie ($\mathbf{F^S}$). $\mathbf{F^S_{ij}}$ =1, indicating the friendship tie between respondent *i* and respondent *j* is Simmelia. Otherwise, $\mathbf{F^S_{ij}}$ =0, meaning that respondent *i* and respondent *j* is not Simmelian connected.

Communication media mix (**M**). Preliminary interviews showed that email and collaborative tool (i.e., Google Documents) are also frequently used for communication and information exchange, in addition to face-to-face meeting. Given the prevailing communication options in class, the communication media mix score was calculated by looking at the ratio of mediated interaction to face-to-face interaction with sources of each recipient. Each respondent was asked to indicate the use frequency (o=never, 1=less than once a week, 2=once a week, 3=more than once a week) of each media that they used to communicate with each identified source. The communication media included face-to-face meeting, email and Google Documents. The range of communi-

cation media mix scores (ratio of mediated/face-to-face) was 0 to 2 with a mean score of 1.03 meaning that the recipient communicated with source almost equally by mediated and face-to-face interactions. Values greater than 1 indicate the majority of communication took place via mediated communication.

Control variables. Several control variables were included in the modeling to eliminate alternative explanations. First, we control social demographic differences, culture difference, by measuring their nationality, where "1" indicate that recipient and source come from the same country while "0" not, due to that culture had been shown to influence the communication [13]. Expertise difference measures their difference in majors, where "1" means two respondents have the same expertise and "0" indicate the opposite; informational demographic difference, i.e., expertise diversity, can influence creativity [38]. We also control their differences in media experience, because existing media experience can influence individual's media choice in the communication process. To measure dyadic media experience difference, we surveyed the respondents to obtain their use frequency of email and Google Documents before enrolling this course; and then calculated the difference; higher values indicate greater difference between two respondents. Finally, because the respondents from the class have common tasks in teamwork, we control their work effort by measuring their weekly work hour in task. "work effort difference" was conceptualized to capture difference in work efforts Greater values mean higher distance between two respondent's work efforts.

4.3 Analyses Strategy

Traditional methods of regression analysis are inappropriate because dyads do not constitute independent observations, and would result in high levels of autocorrelation in the regression results [8]. For this reason, we applied the multinominal logistic regression quadratic assignment procedure (MRQAP) [4] provided in UCINET 6 [5] to analyze the data. The MRQAP regression has been shown to yield unbiased parameter estimates regardless of the degree of autocorrelation. These estimates can be interpreted in the same way as those obtained from standard regressions [21]. Significance levels for correlations and regressions were based on distributions generated from 5, 000 random permutations.

5 Empirical Results

5.1 Preliminary Analyses

Network studies do not usually assess the measurement model as model variables are measured as single items and each network question addresses specific individuals in a network. Table 1 provides the descriptive and correlation statistics for all variables used in our study.

Table 1 includes minimum, maximum, mean, and standard deviation of variable values for the sample in the survey data. Results of QAP correlations show significant correlations of ease of generating creative ideas with key independent variables – Simmelian friendship tie (0.228. p<.05) and Simmelian advice tie (0.334,p<.01). Additionally, the high significant level of correlation between variables is due to the interdependence of network variables, resulting from the non independent network observations [42].

Table 1. Descriptive statistics and correlations.

		Min	Max	Mean	S.D	N	1	2	3	4	5	6	7
1	WD	0	18	3.300	4.038	587	-						
2	MD	0	4	0.937	0.749	586	-0.058	-					
3	CD	0	1	0.629	0.484	587	-0.001	-0.022	-				
4	ED	0	1	0.626	0.484	586	-0.097	-0.023	0.094	-			
5	SF	0	1	0.133	0.339	587	-0.007	-0.027	0.176	0.220	-		
6	SA	0	1	0.187	0.390	587	-0.107	-0.053	0.026	0.028	0.301	-	
7	CM	0	2	1.026	0.537	587	-0.028	-0.068	0.099	0.030	-0.109	0.164	-
8	EI	1	4	2.739	0.757	586	-0.086	-0.046	0.016	0.186	0.228*	0.334**	0.113

(EI: Ease of generating creative ideas, SA: Simmelian advice tie, SF: Simmelian friendship tie, CM: communication media mix, ED: expertise difference, MD: media experience difference, CD: culture difference, WD: work effort difference, *=p<0.05, **=p<0.01)

5.2 Hypothesized Model

The results of MRQAP are displayed in table 2. The hypothesized models seem to provide an acceptable fit to the data with a R2 of 0.164, with adjusted R2 of 0.163. To plot the interaction effects, all predictors are standardized and the interactive terms are the product of standardized independent variables and moderator following Aiken et al. [1].

Hypothesis H1 is supported (b=0.534, p<0.01) from model 2. The recipient is more likely to generate useful and novel ideas in the interaction when he/she and the source share common-third worker(s). It can be seen from table 2 that hypothesis H2 is supported (b=0.275, p<0.01) from model 2. The result means that the recipient is more likely to generate useful and novel ideas in the interaction with source when s/he and the source share common-third friend(s). Regard of H3, regress of model 2 shows it is supported (b=0.146, p<0.01). This finding presents that recipient who engage in proportionally more mediated communication with source will be easier to generate creative ideas, comparing to recipient who engages in proportionally more face-to-face interaction.

Regard to the interaction effects, testing results are shown in model 3. H4 is supported (b=-0.340, p<0.01). Recipient who shares common-third coworker(s) and engages in proportionally more mediated communication with source will be less likely to generate creative ideas, comparing to those who engage in proportionally more face-to-face communication. From figure 2 of interaction plotting, it can be seen that the marginal effect of Simmelian advice tie on ease of generating creative ideas is

stronger when the communication media mix is low than that when it is high, because the slop of the low communication media mix line is greater than that of the high one.

Hypothesis H5 is also supported (b=191, $p<0.05$) from model 3. Recipient who shares common-third friend(s) and engages in proportionally more mediated communication with source will be more likely to generate creative ideas, comparing to those who engage in proportionally more face-to-face communication. It can be seen from figure 3 that the marginal effect of Simmelian friendship tie on ease of generating creative ideas is stronger when the communication media mix is high than that when it is low, because the slop of the high communication media mix line is greater than that of the low one.

We are interested to found that there was a significantly negative relationship between work effort difference and ease of generating creative ideas from model 1, meaning that recipient and source who spent more time together will be easier to generate creative ideas. However, media experience difference will hinder recipient's ease of generating creative ideas from model 1. The result reveals that similarity of media used between will help to generate creative ideas, probably diminishing the communication obstacles. Model 1 also showed there is a significantly positive relationship between expertise difference and ease of generating creative ideas from model 1. The result confirms that knowledge diversity could help to generate creative ideas. However, we did not any find significant relationship between culture difference and ease of generating creative ideas.

Table 2. MRQAP on generating creative ideas.

Control Variables	**Model 1**	**Model 2**	**Model 3**
Intercept	2.655	2.377	2.341
Work effort difference	-0.014**	-0.008**	-0.006*
Media experience difference	-0.046**	-0.023*	-0.026*
Cultureace difference	-0.006	-0.035	-0.031
Expertise difference	0.282**	0.232**	0.235**
Main Effects			
Simmelian advice		0.534**	0.923**
Simmelian friendship		0.275**	0.061
Communication media mix		0.146**	0.178**
Interaction Effects			
SA*CM			-0.340**
SF*CM			0.191*
R^2	0.042	0.160	0.164
Adjusted R^2	0.042	0.159	0.163

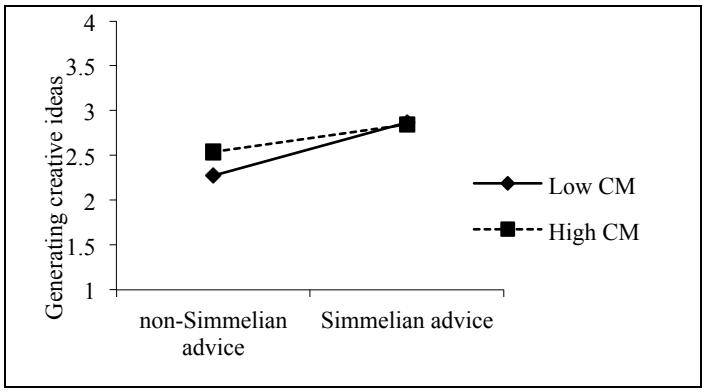

Fig. 2. Interaction effect of Simmelian advice tie with communication media mix.

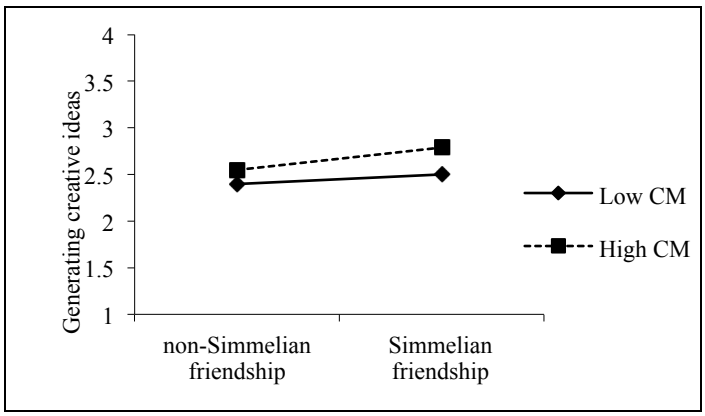

Fig. 3. Interaction effect of Simmelian friendship tie with communication media mix.

6 Discussion

In this study, we examined the relationships among Simmelian advice tie, Simmelian friendship tie and communication media mix on generating creative ideas. The results clearly demonstrate the importance of looking at both the direct and indirect effects of communication media mix on ease of generating creative ideas. When the ratio of mediated communication to face-to-face communication is high, there is an overall positive impact on generating creative ideas. There is a clear, significant impact of common-third part on the interaction between recipient and source both in advice and friendship networks. However, our results present that Simmelian advice tie engaging in more face-to-face communication will be easier to generate creative ideas; while high ratio of communication media mix will strengthen the impact of Simmelian friendship tie on ease of generating creative ideas.

The formation of a shared understanding is promoted by the increased stability among the parties involved in advice network [41]. When a dyad shares common-third worker(s) that strengthens the collaborative environment around them in advice network, it improves the conditions to generate creative ideas between individuals within the dyads [12, 28]. For Simmelian friendship tie, strong friendship influences shared values [18], and enhances open communication [19], due to the emotional attachment [6] that are intrinsic to the tie. The presence of common-third friend(s) can enhance the shared value and open communication between friends, and these factors are associated with the fostering of a collaborative environment favorable to generate creative ideas [28].

Engaging in more proportionally mediated communication is useful for recipient to generate creative ideas when interacting with source. Humans process information differently when it arrives in diverse forms [30]; it is important to use multiple communication media. The total amount of possible communication activity expands along with use of multiple communication media, allowing all participants more air time. The increase in possible communication combined with the potential to generate creative ideas to arise from mediated communication ambiguity, suggest that more mediated communication is better for generating creative ideas. Mediated communication is conducive to creativity because it prevents distraction from face-to-face communication. CAT predicts that more miscommunications may arise when using mediated communication. And this communication ambiguity actually induces creative thinking

Teamwork interaction in non-face-to-face communication is less likely than those who in face-to-face communication to exchange private and relational information at work [26]. This decrease in the amount and type of information shared may hinder the ability of individuals to generate creative ideas, as knowledge diversity is useful to trigger creative ideas generation [38]. As CAT proposes, it is important to see visual cues when explaining something novel using language to be better able to share in face-to-face communication. Thus, engaging in more proportionally face-to-face communication can enhance the impact of Simmelian advice tie on ease of generating creative ideas.

However, close friends are less comfortable when expressing views that are different from others. Additionally, friends can rely on multiple communication media to interact and exchange with each other, due to the geographic and time issues. This discomfort and inconvenience may be lessened when communicating in ways that do not highlight differences, such as in a computer-mediated environment where the recipient and source do not see each other [10]. Therefore, a recipient in more proportionally mediated communication with source in friendship network is more likely to generate creative ideas.

6.1 Theoretical Implications

Our study contributed to the existing literature on creativity by calling attention to dyadic perspective in social network structures. This study emphasized the importance of studying social network phenomenon in organizations from the funda-

mental unit of networks (i.e., dyad), because social interactions within dyads are different as reflected by ties. Diverse knowledge was important for generating creative ideas and shared interests, but the presence of common-third party provided more conducive conditions (social support, extrinsic and intrinsic motivations) for accessing diverse knowledge sources [41].

Our research also made an important contribution to research on individual performance by showing that Simmelian ties could introduce motivations to share, as well as integrate and reconcile heterogeneous knowledge sets which were often taken for granted. Our research reveals that strong tie (i.e., Simmelian ties) can also trigger generation of creative ideas by enhancing the process of interaction inside; further analysis also confirmed this finding by treating tie strength as an predictor. This makes a complementary discussion to the debate of "strength of weak tie theory".

Last but not least, this study explores two theories, CAT and DCT, and their relevance for generating creative ideas. It is argued that the ambiguity of information received via mediated exchange may actually be helpful if the interaction is to generate creative ideas. Furthermore, DCT suggest that people learn and remember things differently depending on how the information was conveyed to them. Our study is one of the first to look at the impact of the combination of different communication media.

6.2 Practical Implications

The findings suggested important practical implications. On one hand, this study provided organizational managers with specific guidelines on how to form and structure a team with Simmelian advice and Simmelian friendship ties in work environment, cultivating collaborative environment for solving problems. Practitioners are encouraged to form cliques in both advice and friendship networks. Organizations should arrange out-work activities for employees to form their friendship network, specifically for R&D department.

The result suggests that mediated communication is equally important, and possible more so in facilitating to generate creative ideas than face-to-face communication. Teams with individuals, who only connected in advice network, should encourage team members to participate in face-to-face meeting for problem solving as much as possible; on the other hand, individuals could use mediated communication tools to interact with their friends for information to solve challenges. However, for those who are both in advice and friendship networks, it is contingent on the timing to implement different communication media. It is reasonable to assume that it is preferred to attend face-to-face meeting at work, while using mediated communication tool to interact with each other when out of work.

6.3 Future Work

This research sought to address the limitations in existing studies by examining dyadic interactions that might be more likely to trigger the generation of novel and useful ideas. However, this research is not without limitations.

In the future research, we would analyze both subjective (e.g., self-reports of network relationships) and objective measures (e.g., logs of email exchanges, product evaluation). Also, we conducted our study in academic organization by using a university course; future work should move the research context to a business organization. However, our results provided some evidences of the roles of Simmelian ties and the main effects of ties and communication media on ease of generating creative ideas, which shed insights on the innovation process in digital collaborations. Finally, it strongly recommends distinguishing effects of different communication tools in advice network and friendship network.

7 Conclusion

This paper aims to enhance our understanding of the generative aspect of creativity by examining it at the dyadic level. We tried to answer the question-- why some dyadic interactions are more likely than others to trigger the generation of novel and useful ideas. The insights generated by this work complement what we have learned from previous studies on creativity as a social phenomenon [e.g., 7, 17, 28]. However, instead of focusing on how the aggregated communication patterns of an individual contribute to his/her ability to produce creative outcomes such as new artifacts (or new proposals or patents), this paper acknowledges that not all dyadic relationships (even for the same individual) are equally good catalysts in the generation of useful and novel ideas, and thus examines precisely how attributes of a specific dyadic interaction affect the generation of creative ideas emanating from it.

References

1. L.S. Aiken, S.G. West, and R.R. Reno. Multiple regression: Testing and interpreting interactions Sage Publications, Inc. (1991)
2. T.J. Allen. Managing the flow of technology MIT press. (1977)
3. T. Amabile. Creativity in Context West View Press, Inc., Boulder, CO. (1996)
4. F.B. Baker, and L.J. Hubert. The analysis of social interaction data. Sociological Methods & Research, 9, 3, (1981), 339
5. S.P. Borgatti, M.G. Everett, and L.C. Freeman. UCINET for Windows: Software for social network analysis. Harvard Analytic Technologies, 6, (2002)
6. D.J. Brass. Power in organizations: A social network perspective. Research in politics and society, 4, (1992), 295-323
7. R.S. Burt. Structural holes and good ideas. The American Journal of Sociology, 110, 2, (2004), 349-399
8. K.M. Carley, and D. Krackhardt. Cognitive inconsistencies and non-symmetric friendship. Social Networks, 18, 1, (1996), 1-27
9. P.R. Carlile. Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. Organization Science, 15, 5, (2004), 555-568
10. J.R. Carlson, and R.W. Zmud. Channel expansion theory and the experiential nature of media richness perceptions. Academy of Management Journal, (1999), 153-170

11. J.M. Clark, and A. Paivio. Dual coding theory and education. Educational psychology review, 3, 3, (1991), 149-210
12. J.S. Coleman. Foundations of social theory Cambridge Belknap Press. (1990)
13. J.N. Cummings. Work Groups, Structural Diversity, and Knowledge Sharing in a Global Organization. Management Science, 50, 3, (2004), 352-364
14. A.R. Dennis, R.M. Fuller, and J.S. Valacich. Media, tasks, and communication processes: A theory of media synchronicity. MIS Quarterly, 32, 3, (2008), 575-600
15. A.R. Dennis, B.H. Wixom, and R.J. Vandenberg. Understanding fit and appropriation effects in group support systems via meta-analysis. MIS Quarterly, (2001), 167-193
16. L. Fleming, S. Mingo, and D. Chen. Brokerage and collaborative creativity. Administrative Science Quarterly, 52, (2007), 443-475
17. L. Fleming, and D.M. Waguespack. Brokerage, boundary spanning, and leadership in open innovation communities. Organization Science, 18, 2, (2007), 165-180
18. D.E. Gibbons. Friendship and advice networks in the context of changing professional values. Administrative Science Quarterly, 49, (2004), 238-262
19. K.A. Jehn, and P.P. Shah. Interpersonal relationships and task performance: An examination of mediation processes in friendship and acquaintance groups. Journal of Personality and Social Psychology, 72, 4, (1997), 775
20. N. Kock. Media naturalness and compensatory encoding: the burden of electronic media obstacles is on senders. Decision Support Systems, 44, 1, (2007), 175-187
21. D. Krackhardt. Simmelian tie: super strong and sticky. in Kramer, R.M., and Neale, M.A.: Power and influence in organizations (CA: Sage, (1998)), 21-38
22. D. Krackhardt, and M. Kilduff. Structure, culture and Simmelian ties in entrepreneurial firms. Social Networks, 24, 3, (2002), 279-290
23. J. Lipnack, and J. Stamps. Virtual teams: Reaching across space, time, and organizations with technology John Wiley & Sons Inc. (1997)
24. P.V. Marsden. Network data and measurement. Annual review of sociology, 16, (1990), 435-463
25. A.P. Massey, and M.M. Montoya-Weiss. Unraveling the temporal fabric of knowledge conversion: A model of media selection and use. MIS Quarterly, 30, 1, (2006), 99-114
26. P.L. McLeod, and J.K. Liker. Electronic meeting systems: Evidence from a low structure environment. Information Systems Research, 3, 3, (1992), 195-223
27. P.R. Monge, M.D. Cozzens, and N.S. Contractor. Communication and motivational predictors of the dynamics of organizational innovation. Organization Science, 3, 2, (1992), 250-274
28. D. Obstfeld. Social networks, the Tertius lungens and orientation involvement in innovation. Administrative Science Quarterly, 50, 1, (2005), 100-130
29. G.R. Oldham, and A. Cummings. Employee creativity: Personal and contextual factors at work. Academy of Management Journal, (1996), 607-634
30. Paivio, and W. Lambert. Dual coding and bilingual memory. Journal of Verbal Learning and Verbal Behavior, 20, 5, (1981), 532-539
31. J.E. Perry-Smith. Social yet creative: The role of social relationships in facilitating individual creativity. Academy of Management Journal, 49, 1, (2006), 85-101
32. R. Reagans, and B. McEvily. Network Structure and Knowledge Transfer: The Effects of Cohesion and Range. Administrative Science Quarterly, 48, (2003), 240-267
33. J. Scott. Social network analysis : a handbook Sage Publications, 2nd edn. (2000)
34. P.P. Shah. Network destruction: The structural implications of downsizing. The Academy of Management Journal, 43, 1, (2000), 101-112

35. P.P. Shah. Who are employees' social referents? Using a network perspective to determine referent others. The Academy of Management Journal, 41, 3, (1998), 249-268
36. G. Simmel, and K.H. Wolff. The Sociology of Georg Simmel Free Pr. (1950)
37. D.K. Simonton. Scientific Genius: A Psychology of Science Cambridge University Press. (1988)
38. M.E. Sosa. Where Do Creative Interactions Come From? The Role of Tie Content and Social Networks. Organization Science, 22, 1, (2011), 1-21
39. T. Sykes, V. Venkatesh, and S. Gosain. Model of acceptance with peer support: A social network perspective to understand individual-level system use. MIS Quarterly, 33, 2, (2009), 371-393
40. S. Thatcher, and S.A. Brown. Individual creativity in teams: The importance of communication media mix. Decision Support Systems, 49, 3, (2010), 290-300
41. M. Tortoriello, and D. Krackhardt. Activating cross-boundary knowledge: the role of simmelian ties in the generation of innovations. The Academy of Management Journal (AMJ), 53, 1, (2010), 167-181
42. E.E. Umphress, G. Labianca, D.J. Brass, E. Kass, and L. Scholten. The role of instrumental and expressive social ties in employees' perceptions of organizational justice. Organization Science, 14, 6, (2003), 738-753
43. S. Wasserman, and K. Faust. Social network analysis: methods and applications: Cambridge University Press. (1994)
44. S.P. Weisband, S.K. Schneider, and T. Connolly. Computer-mediated communication and social information: Status salience and status differences. Academy of Management Journal, (1995), 1124-1151