Research Report: Modifying Paradigms—Individual Differences, Creativity Techniques, and Exposure to Ideas in Group Idea Generation

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In today's networked economy, ideas that challenge existing business models and paradigms are becoming more important. This study investigated how individual differences, groupware-based creativity techniques, and ideas from others influenced the type of ideas that individuals generated. While individual differences were important (in that some individuals were inherently more likely to generate ideas that followed the existing problem paradigm while others were more likely to generate paradigm-modifying ideas that attempted to change the problem paradigm), the exposure to paradigm-modifying ideas from others and the use of intuitive groupware-based creativity techniques rather than analytical groupware-based creativity techniques were found to increase the number of paradigm-modifying ideas produced.

(*Groupware*; *Creativity*; *Idea Generation*; *Feedback*; *Creativity Techniques*; *Individual Differences*; *Cognitive Style*; *Group Simulator*; *Myers-Briggs Type Indicator*; *MBTI*; *Kirton Adaption-Innovation Inventory*; *KAI*)

1. Introduction

Driven by the recent shifts in business models, large companies such as Shell, Nortel, and Proctor and Gamble have undertaken major initiatives to spark innovation and creativity in hopes of generating new paradigm-breaking ideas that can transform their current products and services (Stepanek 1999). Many of these firms have created "idea factories," in which teams brainstorm using e-mail, Web-based groupware, and face-to-face meetings, with the goal of generating ideas that change existing business paradigms (Stepanek 1999). In forming idea factories, most companies have focused on finding creative people and giving them the resources they need because there is a long history that shows that some people are simply more creative than others (Guildford 1950, Amabile 1983, Ford 1996, Woodman et al. 1993). However, the exposure to ideas from other team members and the use of creative problem-solving techniques may be at least as important in creative idea generation (Amabile et al. 1996, Couger et al. 1993, Gallupe et al. 1992,

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VanGundy 1988). In this paper we examine the ways in which groupware-based creativity techniques, the ideas generated by other team members, and an individual's own creative style can influence creativity in terms of the type of idea produced by the participants.

First, we will briefly discuss creativity in general, followed by the ways that creative products may be measured, and the creative process that may lead to the formation of creative products. Next, we will discuss how individual differences, groupware-based creativity techniques, and the contribution of others can play a role in the creative process. The manner in which this research was performed will be covered in the methods sections, and the results will identify our findings. Our final section discusses our findings and their impact on management and further research opportunities.

2. Previous Theory and Research

2.1. Creativity and Creative Products

There are many definitions for creativity. We use the one suggested by Amabile (1983) and refined by Elam and her colleagues (Elam and Mead 1990, Marakas and Elam 1997) that argues that creative products are identified by the extent to which they are novel, as well as appropriate, useful, correct, or valuable. The overall creative process can be broken down into five steps: problem formulation, preparation, idea generation, idea evaluation, and idea selection (Amabile 1983). This study focuses on the heart of this process: idea generation.

The goal of idea generation is to create a pool of candidate ideas for further evaluation and, ultimately, implementation. In some cases, the goal is to create a large quantity of ideas, while in other cases, the goal is to create a few high quality ideas (De Bono 1970, Gallupe et al. 1992). The study of creativity has also emphasized the generation of novel ideas that are different from what has come before (Amabile et al. 1996, Mumford and Gustafson 1988, Oldham and Cummings 1996, Woodman et al. 1993). In this sense, idea novelty represents the rareness or uniqueness of an idea; more obvious (i.e., less novel) ideas will be generated more often, and more novel ideas will occur less often. Idea novelty can be particularly desirable because it can be important in distinguishing a firm from its competitors (Woodman et al. 1993).

In addition to quality and novelty, each idea can also be assessed according to the extent that it supports or challenges the existing paradigms or habitual routines that constrain individual and organizational behavior (Ford 1996, Kirton 1976). A paradigm in this research context refers to the fundamental elements of a problem and the relationships among them (Gryskiewicz 1987), which is slightly different from Kuhn's (1970) definition of a scientific paradigm as a complete and self-contained belief system. Paradigm-preserving (PP) ideas support or extend the existing paradigm; they are evolutionary in that they adapt elements of the existing paradigm. Paradigm-modifying (PM) ideas are revolutionary in that they redefine the problem or its elements (Gryskiewicz 1987, Kirton 1976, Kirton 1989). For instance, in the classic idea-generation problem of "How to use excess capacity of a tea-bag machine?," a paradigm-preserving solution would not attempt to alter the underlying framework of the question (i.e., a machine that makes tea bags needs to be used more). An example of a PP solution would be to put coffee in the tea bags. In contrast, paradigm-modifying ideas would change the relationships among problem components and might consider how to use the tea-bag material in a new form (e.g., mosquito netting). Paradigm-modifying ideas are often novel, yet not all novel ideas are paradigm modifying. It is the novel, paradigm-modifying ideas that are often the goal of the idea factories.

2.2. The Creative Process

While idea generation can be an individual activity performed in isolation, in most cases people do not generate ideas in isolation; often they work with others, as part of a formal or informal group to generate ideas (Drazin et al. 1999, MacCrimmon and Wagner 1994). Idea generation, under these conditions, is both a cognitive and a social process (Nagasundaram and Dennis 1993, Dennis et al. 1999). Individuals first conceptualize an idea (a cognitive process) and then choose whether or not to contribute it (a social process).

The cognitive production of an idea is the first step in idea generation. ACT* theory (Anderson 1983, 1987) argues that cognitive behavior is controlled by production rules—rules specifying the steps of cognition—that produce ideas when activated. Production rules are activated automatically by stimuli, without conscious control (Anderson 1992). For any given stimulus, there are often many production rules that could be activated. Each rule has a certain strength (i.e., likelihood of being activated) based on past experiences and inherent tendencies. The ideas produced depend upon the relative strengths of the individual's production rules.

However, not all ideas that are produced in a participant's mind are actually contributed; the individual must choose to contribute the idea. One of the most fundamental theories of human behavior is the theory of reasoned action (Ajzen and Fishbein 1980, Fishbein and Ajzen 1975). This theory—and its successors, such as the theory of planned behavior (Ajzen 1991)—argues that the decision to behave in a certain manner is affected by the relative importance of an individual's own attitude toward a behavior and the individual's understanding of the subjective norms toward a behavior. Therefore, the decision to contribute an idea is influenced by the individual's attitude toward the idea and his or her perceptions of the subjective norms of others towards the contribution of the idea (Ajzen and Fishbein 1980, Fishbein and Ajzen 1974).[1]

An individual's own attitude toward an idea is affected to a large extent by the production rules that guide the idea's creation. Because individual characteristics play a large role in influencing whether someone chooses to contribute an idea, we could expect those characteristics to be self-reinforcing: Individuals predisposed to creating certain types of ideas would tend to value those ideas more highly and thus be more predisposed to contribute them.

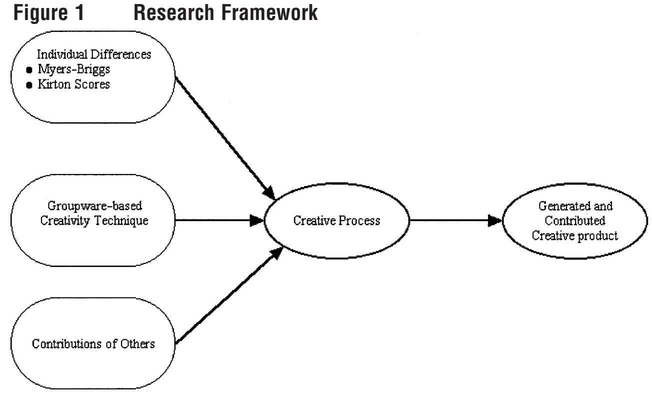
Subjective norms also play an important role in influencing whether an individual chooses to contribute an idea (Ajzen and Fishbein 1980, Fishbein and Ajzen 1975). An individual's understanding of the subjective norms is guided by the formal instructions he or she receives—in this case, the procedures of the idea generation technique the group chooses to use. However, subjective norms are also communicated by the behavior of other members of the group. If other group members follow the formal procedures, those are reinforced and are more strongly presented as subjective norms. However, if other group members do not follow the formal procedures, the formal rules are weakened and the individual may perceive the subjective group norm to be closer to the behavior of other group members.

Therefore, while many factors influence the creative process, this paper explores the impact of individual characteristics, groupware-based creativity techniques, and the contributions of others on the type of ideas an individual produces and chooses to contribute (see Figure 1).

2.3. Individual Differences

Individual differences and cognitive styles play a critical role in creativity, and a significant amount of creativity research focuses on identifying ways to systematically measure and use them (see Amabile 1983, Ford 1996, Guildford 1950, Woodman et al. 1993). Cognitive-style measures are also commonly used in industry to determine the fit between an individual and a task or job (e.g., Myers-Briggs Type Indicator). Yet, before embarking on research that employs the study of individual characteristics and cognitive styles, one has to weigh the pros and cons of such research. On the one hand, if the outcome of the research is to design a system to meet a specific individual's characteristics, such research may result in systems that are of limited use.

Figure 1 **Research Framework**



[1] Ajzen (1991) argues that behavioral intention (the behavior itself) is also affected by the extent to which the individual is actually able to perform the behavior (or perceives his or her ability to perform it). The actual ability to contribute ideas is limited in verbal groups by the need to take turns (Diehl and Stroebe 1987), while the use of electronic brainstorming improves the ability to contribute ideas and thus may also affect behavioral intention.

Given the number of dimensions one can use to characterize an individual's personality and the number of categories within each dimension, it becomes a risky venture to pursue (Huber 1983). Perhaps more importantly, it is unclear whether the system should reinforce one's cognitive style or if it should complement the cognitive style (Huber 1983).

On the other hand, if one utilizes individual differences and cognitive style research to design a system to increase the range of tools and techniques it offers, such research may improve the system design. When the setting, task, and type of desired outcome is known, individual cognitive style may play a role in *selecting* the tools and the techniques to be used. In this case, understanding whether to reinforce or redirect one's natural cognitive style is clearly based on the desired task outcomes (PM or PP ideas). This research looks at two specific dimensions of individual creativity styles to understand how to better select groupware tools and techniques to achieve desired results.

An individual's creativity can be viewed both in terms of the overall level of creativity (i.e., raw creative ability) as well as cognitive style and the types of creative products that are favored (Isaksen and Puccio 1988, Scott and Bruce 1994). Some individuals tend to be systematic thinkers, building on ideas and facts in the problem and focusing on rationality and logic, while others rely more heavily on intuition and imagery, looking beyond current rules, boundaries, and rational logic (Jabri 1991, Scott and Bruce 1994). Individuals who tend towards the production of a certain type of idea tend to be favorably disposed to such ideas and thus more willing to contribute them (Kirton 1976).

One of the most utilized measures of overall personality type that includes the distinction between a systematic, data-based cognitive style and an intuitive, image-based style is the Myers-Briggs Type Indicator (MBTI) (Myers 1987, Myers and Briggs 1952). While the MBTI is very popular among practicing managers, there has been some criticism of its stability (Cowan 1987, Lorr 1991, McCrae and Costa 1989, Furnham 1996). We choose to use it as one of two measures of cognitive style for both theoretical and practical reasons. First, for theoretical reasons, it measures the cognitive processing and organizing of information (i.e., the idea generation aspect of the study) and the characteristics that impact the way in which one makes judgments and conclusions, including the decision to contribute one's ideas (Myers and McCaulley 1985, Ruble and Cosier 1990). Second, the MBTI instrument is extremely popular in industry; research findings that include methods for using portions of a widely used instrument may have greater relevance to organizations than those based on seldom used research measures.

Although the MBTI has four sub-scales, two dimensions are of particular interest. The Sensor-iNtuitor sub-scale (S-N) assesses the extent to which individuals view reality in terms of data and facts without considering alternative meanings (S: sensors). At the other end of the scale are those who "go beyond what is immediately present in a situation" (Ruble and Cosier 1990, p. 285), using intuition to see beyond objective reality to the subtle inner relationships (N: intuitors). Intuitive people have the propensity to integrate information from different paradigms simultaneously, giving them a high likelihood of generating novel ideas (Isaksen 1987). The Thinker-Feeler subscale (T-F) assesses the extent to which individuals use a rational, systematic process to understand reality through analysis and logical inference (T: thinkers), versus those who emphasize images and feelings (F: feelers). Intuitive thinkers (N) who use imagery (F) should be more likely to produce and contribute novel ideas and paradigm-modifying ideas than those who are systematic (T), data-based (S) thinkers, because they have a greater propensity to process information from different paradigms and combine it in novel ways (Ford 1996, Isaksen and Puccio 1988, Scott and Bruce 1994, Ruble and Cosier 1990). We hypothesized:

HYPOTHESIS 1A: *Intuitor-Feelers (NF) will generate more novel and more paradigm-modifying ideas than Sensor-Thinkers (ST).*

In addition to the MBTI that assesses one aspect of cognitive style, Kirton (1976) observed that individuals who possess the same creative ability may approach creative problems in one of two distinct ways. Some individuals (adaptors) tend toward using adaptive approaches that seek incremental changes that adapt or stretch the current problem elements or ideas. Others (innovators) lean toward more revolutionary ideas by redefining or restructuring the problem rather than accepting the current situation as a starting point. Neither style is better than the other; it is the fit between the style and the task that impacts task performance (Scott and Bruce 1994, Payne et al. 1990). Innovators are more likely to produce and contribute novel, paradigm-modifying ideas (Kirton 1976). Therefore:

Hypothesis 1b: *Innovators will generate more novel and more paradigm-modifying ideas than adaptors.*

2.4. Groupware-Based Creativity Techniques

The type of idea produced is not only a function of individual creativity and style, but also of the creative technique used (Payne et al. 1990). Anderson (1983, 1987) argued that cognitive behavior is controlled by production rules—rules specifying the steps of cognition—that produce ideas when activated. Different techniques can help individuals to see problems differently and thus trigger different production rules, resulting in different types of ideas.

Many different creativity techniques have been developed to focus and enhance creativity (VanGundy 1988) and may be classified by the cognitive processes they attempt to induce. Couger (1995) classified techniques as analytical or intuitive. Analytical techniques generate logical patterns of thought which "tend to follow a linear pattern or sequence of steps" (Miller 1987, p. 66). Intuitive techniques "rely on a single image or symbol to provide a whole answer all at once . . . to arrive at solutions by a leap" (Miller 1987, p. 66). Analytical techniques should be more paradigm preserving because they encourage incremental steps, while intuitive techniques should be more paradigm modifying in that they encourage a more holistic view of the problem.

Formal techniques also serve as a vehicle to convey social norms by defining the types of behaviors and ideas that are desirable. As such, they help regulate the ideas contributed by affecting the behavioral intention to contribute ideas. Ideas that conform to the social norm prescribed by the technique are more likely to be contributed than those ideas that do not (Ajzen and Fishbein 1980, Fishbein and Ajzen 1974). Therefore, techniques are not only designed to stimulate the use of specific cognitive processes, but they also create a social environment that reinforces the generation of specific types of ideas. Thus:

Hypothesis 2: *The use of intuitive groupware-based creativity techniques will promote the generation of more novel and paradigm-modifying ideas than the use of analytical groupware-based creativity techniques.*

2.5. Contributions of Others

The contributions of other individuals who are engaged in similar idea-generation activities affect both the ideas produced and the subset of ideas actually contributed (Drazin et al. 1999). From a cognitive perspective, it is the external stimuli—the ideas from others—that trigger one's own cognitive activities (Anderson 1992). Ideas that are more novel and paradigm modifying are more likely to result in the activation of the set of production rules likely to produce more novel and paradigm-modifying ideas (Satzinger et al. 1999). Ideas that are less novel and paradigm preserving are more likely to activate the set of production rules likely to produce less novel and paradigm-preserving ideas.

The contributions of others are also likely to affect one's perception of the subjective norms. When others' contributions share similar characteristics (i.e., novel, paradigm-modifying ideas versus less novel, paradigm-preserving ideas) participants are more likely to choose to contribute ideas that conform to those patterns. Therefore:

Hypothesis 3: *Individuals exposed to more novel and paradigm-modifying ideas will generate more novel and paradigm-modifying ideas.*

2.6. Interaction Between Contributions of Others and Technique

Ensuring that participants follow the rules of a technique can be a challenge (Hackman and Kaplan 1974, Jablin and Seibold 1978). When others' contributions follow the rules of the groupware-based creativity technique, the subjective norms for that technique are reinforced and participants are less likely to choose to contribute ideas that do not conform. Conversely, if participants see others not conforming to the rules, the subjective norms become a weaker influence in constraining behavior; participants are more likely to contribute nonconforming ideas (Ajzen and Fishbein 1980, Fishbein and Ajzen 1975). Therefore:

HYPOTHESIS 4: *Individuals exposed to ideas that conform to the groupware-based creativity technique will be more likely to generate ideas that conform to the technique.*

3. Method

Our focus is on individual creativity within group settings. We could simply study individuals interacting in groups, but the ideas in each group session and the amount of influence from group members can vary across groups. This introduces greater variance and less precision in the measures. It is also expensive in terms of the number of subjects that must be used. Many approaches to reducing the number of subjects and the variance across groups have been considered, such as the use of confederates (e.g., Connolly et al. 1990, VanDyne and Saavedra 1996) and mathematical modeling (e.g., Stasser 1992).

Groupware opens a new possibility: group simulators (Satzinger et al. 1999). A group simulator looks and acts like a groupware system, but instead of sharing ideas among participants, the simulator presents participants with comments that appear to be from other participants but which are, in fact, drawn from a database of preset ideas. Simulators increase experimental control by enabling a very specific and precise experimental environment in which to test hypotheses. Each subject now receives the same stimulus, so there is less random variation than is usually encountered in groups. A group simulator was used in this study.

3.1. Participants

Participants were 219 undergraduate business students enrolled in a core business course. The average age was 20.6 years; 45% were female. Participants were randomly assigned to one of four treatment conditions. Each participant worked alone at a computer using a group simulator. Participants were, however, informed that they were working as a group via an electronic brainstorming system with the other participants.[2]

3.2. Task

The task used in this experiment asked participants to develop possible solutions to the lack of available parking on campus. From a research perspective, this task has a number of desirable characteristics. First, the task was relevant to the subjects, which promotes higher involvement and enables participants to draw on personal knowledge and experiences (Connolly et al. 1990). Second, the task has been used extensively in prior research (e.g., Connolly et al. 1990, Gettys and Fischer 1979). Finally, the task is sufficiently complex as to have hundreds of possible solutions.

3.3. Independent Variables

There were four independent variables in this experiment: two measures of individual characteristics (personality type and creativity style), plus two process variables (creativity technique and the stimuli from "other participants") that were actively manipulated. We also measured each individual's overall creativity level as a covariate because overall creativity may influence the novelty and PP/PM of the ideas generated (Wierenga and van Bruggen 1998, Massetti 1996). Overall creativity level was assessed using the Creative Thought and Innovative Action Inventory (CTI) which has 36 (6-point) items (Hellriegel and Slocum 1974). The alpha was 0.85, indicating adequate reliability.

Personality style was measured using the Sensing-iNtuiting (S-N) and Thinking-Feeling (T-F) subscales of the Myers-Briggs Type Inventory (MBTI) (Myers and Briggs 1952). The two subscales were combined into one item, each with four categories (NT, NF, ST, SF). Creativity style was measured via the Kirton Adaptor Innovator (KAI) instrument (Kirton 1976), which has 33 (5-point) items that identify a person's preferred cognitive style. The alpha was 0.86, indicating adequate reliability. The KAI measure was not normally distributed; it was skewed with a long tail into higher values. Therefore, we performed a logarithmic transformation, which reduced the skew before performing the analyses.

Two types of groupware-based creativity techniques were used: Force Field Analysis and Guided Fantasy (Couger 1995, VanGundy 1988). The Force Field Analysis technique (FF) is an analytical technique (Couger 1995) that examines the forces contributing to or hindering a solution to the proposed problem (parking on campus). For the experimental task, each participant was given a list of 10 forces to use as stimuli to generate

[2]While participants were informed that they were working in a group, it is possible that some participants believed they were in fact using a simulator, but we have no evidence of this.

solutions to the proposed problem. Examples of forces causing the problem included "Parking lots are only one level" and "Increased enrollment of students." Forces helping to eliminate the problem included "There are some underutilized areas of the campus," and "There are places to park off campus." See the Appendix for additional information.

The Guided Fantasy technique (GF) is an intuitive technique (Couger 1995) that instructs participants to use a fantasy world distant from the problem to help think of unusual ideas to solve the proposed problem. In this case each participant was given a description of a trip on the space shuttle as their fantasy world. This scenario provided an environment unrelated to the task as a stimulus for generating solutions to the proposed problem. See the Appendix.

The final independent variable was the stimuli from "other participants" (i.e., the ideas programmed into the simulator), whether high novelty/PM or low novelty/PP. The ideas in the simulator were drawn from a prior experiment that asked participants to perform the same task. All ideas were scored for quality, novelty, and paradigm relatedness (PP/PM). Ideas were first independently rated by two raters for quality. Good ideas were defined as solutions that were appropriate, useful, correct, or valuable to the problem. Any idea assessed as "not good" by either rater was discarded from further consideration.

Next, two raters assessed each idea on a 5-point scale as being 1 (most paradigm preserving (PP)) to 5 (most paradigm modifying (PM)). The parking-problem ideas were classified as follows: If the ideas revolved around increasing the number of parking spaces (e.g., build more parking lots), or managing automobiles and the need to park them (e.g., reducing the number of parking stickers), the ideas were scored as a 1 or 2, respectively, and were classified as PP. If the ideas focused on the larger problem of transporting people to the university (e.g., using bicycles or moving sidewalks), delivering education to the students (e.g., TV-based classes, classes in dorms), or higher social goals (e.g., incorporating training in the workplace), the ideas were scored as a 3, 4 or 5, respectively, and were thus classified as PM ideas. Initial interrater agreement was 81%, and after reconciliation efforts, 100% agreement was reached.

The ideas were then scored for their novelty. Idea novelty can be measured in many ways (MacCrimmon and Wagner 1994). We used the frequency count approach: Ideas mentioned fewer times than the mean frequency (4.1) were considered novel.

We then selected ideas for the simulator for the two treatments. Ideas for the high novelty/PM treatment had to be both novel and PM. Ideas for the low novelty/PP treatment had to be both not novel and PP.

3.4. Procedures

Participants reported to the experimental site, a computer lab, in groups. They first completed the CTI, KAI, and MBTI instruments and provided demographic information. Participants were then trained in one of the creativity techniques and in the use of the simulator. Participants were informed that the simulator was an electronic brainstorming tool that would enable them to share their ideas with other participants and receive ideas from others. They then worked using the simulator on a practice task to familiarize them with the simulator and the groupware-based creativity technique. The participants were then asked to generate as many solutions as possible to the campus parking problem. After 15 minutes, the participants completed a brief, postsession questionnaire, were debriefed, and released.

3.5. Dependent Measures

The dependent measures in this experiment were the number of novel ideas and the number of PM ideas that were typed into the software by each subject. An idea was identified as a unique (i.e., nonredundant) idea using the coding rules of Gallupe et al. (1992); that is, when it added a new piece of information that pertained to the task domain beyond what the participant had previously typed. The number of novel ideas was assessed by counting the number of times each unique idea was mentioned by all subjects in this current experiment (the more times it was mentioned, the less novel it was). Ideas mentioned less than the mean number of occurrences (2.2) were classified as novel. Classifying an idea as PP or PM was done by matching it to an idea in the experiment from which the simulator ideas were drawn and using the PP/PM classification for that idea. Only 43 ideas (7%) in our study could not be matched to ideas in the prior study. These

Table 1 Means (and Standard Deviations) of Ideas Generated

	Novel Ideas		Paradigm-Modifying Ideas	
	Mean	Std	Mean	Std
Technique				
Analytical (Force Field)	1.80	1.85	2.84	2.20
Intuitive (Guided Fantasy)	2.48	1.99	4.06	2.69
Stimuli				
Paradigm Preserving (PP)	1.99	1.95	3.00	2.54
Paradigm Modifying (PM)	2.23	1.93	3.77	2.41
Technique x Stimuli				
Analytical (FF) with PP	1.68	1.83	2.58	2.13
Analytical (FF) with PM	1.95	1.84	3.15	2.25
Intuitive (GF) with PP	2.39	1.99	3.59	2.62
Intuitive (GF) with PM	2.61	1.98	4.59	2.68
Overall Creativity (CTI)				
Lower CTI	1.78	1.85	2.85	2.10
Higher CTI	2.20	1.96	3.55	2.59
Personality Type (MBTI)				
NF	2.26	1.57	4.44	2.36
NT	2.59	2.29	3.47	1.97
SF	2.07	1.82	3.34	2.24
ST	1.90	1.97	2.99	2.75
Creativity Style (KAI)				
Lower KAI	2.07	2.21	3.17	2.72
Higher KAI	2.16	1.65	3.62	2.27

Note. Because CTI and KAI were continuous measures, we partitioned the data into two sets for display in this table. (The continuous data were used in the statistical analyses.) Those individuals scoring at or below the mean score for all subjects were classified as lower CTI and lower KAI, respectively, with those scoring above the mean as higher CTI and higher KAI, respectively.

Table 2 Statistical Results

	Novel Ideas		Paradigm-Modifying Ideas	
	F	p	F	p
Technique	9.11	0.003**	16.23	0.001***
Stimuli	1.78	0.184	8.20	0.005**
Technique x Stimuli	0.08	0.773	0.15	0.704
Overall Creativity (CTI)	3.70	0.056	10.45	0.001***
Personality Type (MBTI)	2.45	0.065	3.23	0.024*
Creativity Style (KAI)	5.01	0.026*	4.54	0.034*

*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

43 ideas were rated using the same process originally used to classify ideas from the prior study (some being rated as PP and some as PM depending on the idea).

4. Results

The data were analyzed with ANCOVA using creativity technique, stimuli, technique by stimuli interaction, KAI, CTI, and MBTI as independent variables. Means and standard deviations are presented for each treatment in Table 1, with statistical results in Table 2. As an aside, we note that there were no statistically significant differences in the number of unique ideas produced in any of the experimental manipulations, although individuals with higher CTI scores produced significantly more unique ideas.

The first set of hypotheses examined the relationship between individual characteristics and ideas. Hypothesis 1a, which argued that MBTI iNtuitors-Feelers would generate more novel ideas ($F(3, 208) = 2.45$, $p = 0.065$) and more paradigm-modifying ideas ($F(3, 208) = 3.23$, $p = 0.024$) than MBTI Sensor-Thinkers, was only partially supported. Post-hoc Tukey tests found significant differences in PM ideas between MBTI iNtuitors-Feelers and MBTI Sensor-Thinkers. Hypothesis 1b, which contended that KAI innovators would generate more novel ideas ($F(1, 208) = 5.01$, $p = 0.026$) and more paradigm-modifying ideas ($F(1, 208) = 4.54$, $p = 0.034$) than KAI adaptors, was supported.

The second set of hypotheses examined the effects of the technique and external stimuli. Hypothesis 2, which argued that the use of intuitive creativity techniques would result in more novel ideas ($F(1, 208) = 9.11$, $p = 0.003$) and more paradigm-modifying ideas ($F(1, 208) = 16.23$, $p = 0.001$) than the use of analytical groupware techniques, was supported. Hypothesis 3, which contended that the exposure to more novel and paradigm-modifying stimuli ideas would result in more novel ideas ($F(1, 208) = 1.78$, $p = 0.184$) and more paradigm-modifying ideas ($F(1, 208) = 8.20$, $p = 0.005$) than the exposure to less novel and paradigm-preserving ideas, was only partially supported. Hypothesis 4, which argued that the combination of technique with stimuli matching the technique would encourage a greater conformance to the technique was not supported; there was no significant interaction effect between technique and stimuli for novel ideas ($F(1, 208) = 0.08$, $p = 0.773$) or paradigm-modifying ideas ($F(1, 208) = 0.15$, $p = 0.704$). That is, technique and stimuli are additive, not multiplicative in their effects on the generation of novel and PM ideas.

5. Discussion

Our results show that individual characteristics, groupware-based creativity techniques, and stimuli from others affect idea generation (and the number of paradigm-modifying ideas in particular). Individuals who were MBTI intuitor-feelers (NF) or KAI innovators generated more paradigm-modifying ideas than did MBTI sensor-thinkings (ST) or KAI adaptors. KAI innovators also generated more novel ideas. The use of an intuitive creativity technique (Guided Fantasy) resulted in more novel and more paradigm-modifying ideas. Individuals also generated more paradigm-modifying ideas when exposed to more paradigm-modifying ideas from other "members" of their simulated group.

These results suggest that while individuals with different creative abilities and styles tend to generate different types of ideas, the use of different techniques can sway the type of ideas that individuals generate. While a faithful adoption of a technique by others increases the impact of the technique, the technique still has an impact even when others unfaithfully adopt a technique (as simulated here when subjects using the intuitive technique received PP ideas and when those using the analytical technique received PM ideas).

Creativity techniques and exposure to external stimuli greatly influenced the generation of PM ideas, independent of individual characteristics. In our study, as in others (Kirton 1976), both KAI innovators and KAI adaptors generated both PM and PP ideas. While innovators generated a greater number of PM ideas than adaptors, both were influenced by the technique and the ideas of "others." Thus, while it may be difficult to alter an individual's innate creativity and problem-solving style, it is possible to influence the creative products they generate by altering the process. One can systematically induce people who do not normally generate many PM ideas to generate more PM ideas (and vice-versa) by changing the technique and the group members with whom they work.

These conclusions suffer from the usual limitations of laboratory experiments using student subjects (see McGrath 1982) and thus additional research is necessary to understand the extent to which these findings may generalize to different environments and different individuals. Nonetheless, we believe that these results suggest three implications for managers who want to generate more paradigm-modifying ideas that break habitual organizational routines.

First, because each person has a personality type and creative style that favors the generation of paradigm-modifying or -preserving ideas, the selection of MBTI iNtuitors-Feelers, and KAI innovators is recommended for projects whose goals are to break paradigms, such as idea factories. Managers ought to keep in mind that both innovators and adaptors can be of great value to an organization. All too often, novel and paradigm-modifying ideas are generated but are never implemented due to their inherent clash with existing organizational structures. Group work may enable the company to benefit from using innovators to generate novel and PM ideas and adaptors to help implement and incorporate these new ideas into existing work structures.

Second, in the past, our advice to managers wanting to generate paradigm-preserving or paradigm-modifying ideas would have been to select people with the appropriate cognitive style. While this is still true, we can expand this to include selecting the type of technique to match the type of idea desired. In this study, the perceived faithful use of the Guided Fantasy technique increased the generation of paradigm-modifying ideas by more than 75% over the perceived faithful use of an analytical technique (4.59 vs. 2.58 in Table 1); even in the face of its unfaithful use by some team members (i.e., intuitive techniques with paradigm-preserving stimuli), it resulted in almost 40% more paradigm-modifying ideas (3.59 vs. 2.58).

Third, a less frequently explored aspect of creativity is organizational memory (Walsh and Ungson 1991). Information technology can capture ideas for use as stimuli in future meetings. This offers the potential of enhancing creativity between teams on the same project or for iterative work of the same team by using existing ideas as "seeds." As Osborn (1953) hypothesized, even wild (potentially unfeasible) ideas can inspire feasible solutions from others. Thus, seemingly unproductive idea generation sessions can fuel more productive subsequent meetings. And, as shown through the use of the Guided Fantasy technique, solutions to problems unrelated to the problem at hand can inspire novel, paradigm-modifying ideas.

Likewise, we believe that these results suggest three implications for future research. First, we conclude that the use of group simulators can play a useful role in the study of group creativity, and—perhaps—in the study of other group processes such as decision making. The use of the simulator greatly improved precision of the experimental design without the cost of confederates and has the potential to simplify future research.

Second, in this study, we did not hypothesize or attempt to assess the differential impacts of the process on individuals with different characteristics. One might hypothesize, for example, that the use of intuitive techniques by MBTI intuitors and KAI innovators would have a significantly stronger impact than its use by MBTI sensors and KAI adaptors, because the technique "fits" their personal characteristics. Conversely, one might hypothesize the reverse because the technique "compensates" for their personal characteristics. Additional research is warranted to understand the ways in which individuals with different creativity levels, personality types, and creativity styles respond to different types of creativity techniques.[3]

Finally, most groupware research has focused on the use of analytical creativity techniques, such as brainstorming. This research highlights the necessity to consider incorporating tools into the groupware that will enhance or harness individual characteristics to meet specific task outcomes. By understanding the role individual characteristics play in the creative process, systems can be designed to broadly incorporate tools to leverage individual characteristics.

In the almost two decades since Huber's (1983) original indictment of cognitive-style research, we have seen empirical research on individual differences wither away. Yet at the same time, we have seen a greater theoretical understanding that the appropriation and use of technology—and the ultimate outcomes of that use—are significantly affected by important differences in both individual and group characteristics and norms (DeSanctis and Poole 1994). In this study, individual differences had a significant and predictable effect on performance that we believe could be useful in designing and using groupware when the goals of the task could be articulated (PP vs. PM ideas). This research only begins to investigate how different tools and techniques can be implemented in a groupware system to enhance performance. Perhaps now is the time to modify our own research paradigms and to begin anew to investigate and understand the role of individual differences in the design, enhancement, and use of information systems.

Appendix. Idea Generation Tasks

Campus Parking Task (Force Field Analysis)

Many students have experienced the frustration of not being able to find a parking space on campus. You are asked to help us resolve the campus parking problem. We have outlined some forces that are creating our parking problem and some forces that may be helpful in eliminating the problem. Using this list of forces, please generate more specific ideas that would strengthen the forces working to eliminate the university's parking problem or weaken the forces that currently cause the university's parking problem.

Problem. How can we solve the university's parking problem?

Worst case scenario:	**Optimal solution:**
Student parking on campus is next to impossible	Students can find convenient parking whenever they need it

Forces causing the parking problem	**Forces working to eliminate the parking problem**
Increased enrollment of students	There are other forms of transportation
Shortage of parking spaces	Many students live close to one another
Peak hours students are on campus	Cost of parking has increased

[3]We conducted a post-hoc analysis that introduced techniques by CTI, MBTI, and KAI interaction terms into the statistical model, but there was sufficient multicolinearity to make the results uninterpretable.

Campus Parking Task (Guided Fantasy Method)

For this task you are asked: How can we solve the university's parking problem?

Many students have experienced the frustration of not being able to find a parking space on campus. You are asked to help us resolve the campus parking problem. Use the following descriptions of vacation destinations to stimulate your thinking about new ways to solve the university's parking problems.

Destination 1. A Trip on the Space Shuttle

This vacation is a working vacation where you can be part of history. NASA is running a living laboratory on their next shuttle mission and you can participate in this exciting adventure. First you will attend a two-week class to prepare you for your adventure into outer space. You will learn to maneuver in a weightless environment and how to help in the many experiments that will be taking place on board the shuttle. While in space you will be able to communicate with NASA via a video conferencing screen. As you fly high above the earth you will learn about the breeding habits of rabbits, the effects of carbon monoxide in a weightless environment, and the way light travels through outer space. There are plenty of opportunities for you on board the shuttle, but you can determine what experiments you are most interested in and help out in those areas. This is a once-in-a-lifetime adventure. Take care, Major Tom, we will see you when your spacecraft reaches the ground!

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