PERSONALITY, PROCESS, AND PERFORMANCE IN INTERACTIVE BRAINSTORMING GROUPS

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ABSTRACT: This study assessed the impact of group-level personality on the processes and outcomes of brainstorming groups. Subjects were 312 students who were randomly placed in 78 four-person groups. Measures included personality, group processes, and group outcomes. Results showed that mean extraversion had significant negative relationships with group process variables. Mean openness had significant positive relationships with group outcomes, but was not related to the group process variables. Finally, mean emotional stability was not related to group process variables but did have a significant relationship with a group outcome. Implications of these findings and areas for future research are briefly discussed.

KEY WORDS: brainstorming; group processes; groups; personality.

INTRODUCTION

Due in part to the rising popularity of groups and teams in organizations (Guzzo & Salas, 1995), researchers have begun to focus on characteristics that distinguish effective groups from ineffective groups. The theoretical paradigm that drives much of the research on group effectiveness is based on open systems theory in which group input variables (e.g., member personality, skill, and knowledge) are trans-

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formed into group outcomes (e.g., the quality and quantity of the group product) through group interaction processes such as communication, task strategy, and effort (Gladstein, 1984; Hackman & Morris, 1975; Steiner, 1972). The flexibility of the basic input–process–output (IPO) model is demonstrated by its widespread use and application to a variety of settings (Campion, Medsker, & Higgs, 1993; Driskell, Hogan, & Salas, 1987; Littlepage, Schmidt, Whisler, & Frost, 1995).

Implicit in the IPO model is the idea that a group's actual productivity (outputs) rarely reaches the level of its potential productivity, because a group's resources (inputs) are transformed using inefficient group processes. For example, research has consistently shown that interactive brainstorming groups produce significantly fewer ideas than the same number of individuals working alone, because the process of group interaction disrupts individual performance (Graham & Dillon, 1974). The process losses that are experienced by brainstorming groups are particularly well documented (Diehl & Stroebe, 1987). While some authors have argued for the possibility of process gains, empirical evidence in support of process gains has been somewhat scarce (Paulus, 2000).

Several researchers have investigated the antecedents of process loss in brainstorming groups (see Paulus, 2000 for a review). Among the various antecedents of process loss that have been identified, the personality composition of the group is beginning to draw more attention. One explanation for the growing interest in group personality composition lies in its logical relationship to performance in both individual and group conditions. Effective performance of a brainstorming task by an individual is contingent on fewer traits (only those traits that are relevant to idea generation) than effective group performance (which also requires traits that are relevant to effective group participation).

The purpose of the present study is to determine if the personality composition of an interactive brainstorming group has an impact on the group's processes and subsequent productivity. It is believed that group personality composition can be used to distinguish effective brainstorming groups from ineffective brainstorming groups and that the relationship between personality and group productivity is mediated by group interaction processes. Examination of this topic will help to integrate several strands of previous research, replicate previous findings, and extend the brainstorming literature in a new direction.

Theoretical Orientation

The current study stems from an influential review and theoretical integration of the personality and group performance literature by

Driskell, Hogan, and Salas (1987). In their review, the authors concluded that a group's personality composition, interaction processes, and outcomes are related in a manner that is consistent with the general form of the IPO model. However, they believed that the specific relationships between a group's personality, processes, and outcomes are highly dependent on the type of task the group performs. Because every task requires a unique set of inputs and processes to achieve the desired outcome, the specific form of the IPO model is also unique to each type of task.

According to the Driskell et al. (1987) framework, the process of constructing a task-specific IPO model involves a series of specification steps. In reference to the current study, brainstorming is classified as an imaginative/aesthetic task in the Driskell et al. framework. The personality traits that are hypothesized to be predictive of performance for imaginative/aesthetic tasks correspond to the five-factor model dimensions of openness, emotional stability, and extraversion. Although some researchers have suggested that group-level conscientiousness and agreeableness also have an impact in brainstorming groups (Buchanan, 1998; Waung & Brice, 1998), Driskell et al.'s framework clearly states that conscientiousness and agreeableness will have little predictive value for imaginative/aesthetic tasks. Therefore, conscientiousness and agreeableness were not included in the current discussion, but exploratory results will be reported for both traits as a springboard for future research.

The rationale behind the inclusion of openness, emotional stability, and extraversion is as follows. Openness reflects the general tendencies of originality and creativity, which are prime requirements for imaginative/aesthetic tasks (Driskell et al., 1987). Emotional stability was selected, because Driskell et al. concluded that poorly adjusted persons tend to disrupt group interaction and coordination no matter what types of task performance may be required. Extraversion was selected, because uninhibited behaviors are required for task completion (i.e., individuals must share ideas with other group members).

Aggregation of Personality Traits

Because personality is measured at the individual level of analysis (i.e., each group member has a score for each personality trait), a researcher who wishes to study group-level personality must devise a method for combining the scores of each group member into a single score for the group (Rousseau, 1985). Determining the appropriate method of aggregation is crucial to establishing valid predictor–criterion relationships (LePine, Hollenbeck, Ilgen, & Hedlund, 1997).

Steiner (1972) provides general recommendations concerning the aggregation of individual scores to the level of the group based on how

member contributions are combined. In brainstorming, each individual contributes ideas, and the group product is the sum of all of the non-redundant ideas produced by the group in the allotted time period. The ideas contributed in a group brainstorming session are also routinely evaluated by finding the sum of their quality. Brainstorming, then, is primarily an additive task. An appropriate method of aggregating personality scores for additive tasks is to calculate the group mean. Using the group mean also makes sense from a theoretical standpoint; each group member contributes to the group interaction and outcomes even if his or her "contribution" is to remain silent and disengaged.

Brainstorming also has elements of conjunctive, disjunctive, and compensatory tasks. So, the maximum, minimum, and variability of group members' scores could also be appropriate methods of aggregating personality scores for brainstorming tasks (Steiner, 1972). However, previous research has shown that these different aggregation methods are highly correlated with each other, essentially providing redundant information (Barrick et al., 1998). For the sake of completeness, results for the maximum, minimum, and variability of trait scores will be reported, but they will not be included as part of the proposed model.

Group Processes

Although many different process losses for brainstorming groups have been identified (see Paulus, 2000), three have received the most attention in the brainstorming literature: production blocking, evaluation apprehension, and social loafing (Dennis & Valacich, 1993; Diehl & Stroebe, 1987; Shepherd, Briggs, Reinig, Yen, & Nunamaker, 1995–96). Production blocking refers to losses that occur because only one individual can share ideas with the group at a time. Evaluation apprehension refers to losses that occur due to fear of negative evaluations from other group members. Social loafing refers to the tendency of individuals to reduce their effort in the presence of others.

Outcomes

For brainstorming groups, both the quantity of ideas generated and the quality of ideas are important. Although previous research has shown that quantity and quality of ideas are strongly related (Diehl & Stroebe, 1987), both are important outcomes of brainstorming groups (Barki & Pinsonneault, 2001). Some authors have argued for the importance of other group outcomes including group satisfaction, participation, and cohesion (Kramer, Kuo, & Dailey, 1997; Van de Ven & Delbecq, 1974). However, the traditional focus of brainstorming research and the focus of the Driskell et al. (1987) framework is on performance outcomes. The examination of attitudinal outcomes will therefore be reserved as a topic for future studies.

Relationships

Previous research (Costa & McCrae, 1992) has shown that the personality traits of the five-factor model are loosely correlated. Therefore, no relationships were specified among the personality traits. According to the general form of the IPO model, the effects of group-level personality characteristics on group performance can be traced through their impact on the group process variable (Driskell et al., 1987). In other words, no direct relationships between personality traits and group outcomes are expected. Instead, each personality trait is expected to have a negative relationship with each interaction process. Previous research (Diehl & Stroebe, 1987, 1991) has also shown that each of the group processes can function independently and that the combined effect of social loafing, evaluation apprehension, and production blocking is a large process loss for brainstorming groups. However, researchers have not determined which processes are most closely related to idea quality and idea quantity. Besides, quality and quantity are closely related in brainstorming groups. In other words, no relationships are expected among the process variables, but all of the group process variables are expected to have negative relationships with both of the group outcome variables.

Figure 1 shows a theoretical IPO model of brainstorming that is based on the work of Driskell et al. (1987) and summarizes the preceding discussion. The model shows that group-level personality traits predict the task-specific group processes of social loafing, evaluation apprehension, and production blocking. These processes predict the task-specific outcomes of quality of ideas and quantity of ideas. Furthermore, the model shows that group processes mediate the relationships between personality and outcomes.

Figure 1
Proposed model of Group Brainstorming
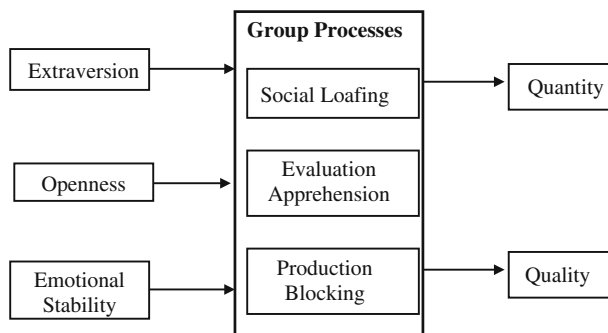
Research Support for the Proposed Model

Several authors have examined the specific causes of the process losses experienced by brainstorming groups. Although authors do not always agree on which process is most important, it is generally accepted that social loafing, evaluation apprehension, and production blocking are the primary determinants of the process losses experienced by brainstorming groups (Diehl & Stroebe, 1987; 1991; Harkins & Jackson, 1985; Shepherd et al., 1995–96). Previous research has shown that these processes can function independently and lead to a decrease in both the quality and quantity of ideas produced in a brainstorming group. Furthermore, research has shown that these process losses can be reduced or eliminated by manipulating the group context.

Openness

Some support is also found for the proposed link between openness and a group's interaction processes. Groups with a higher mean openness have less social loafing because they find the brainstorming task intrinsically motivating (Bond & Shui, 1997). Conversely, groups that are closed to experience have little motivation to be creative (McCrae, 1987). In addition, groups with a higher mean openness have lower levels of evaluation apprehension due to their superior abilities (Graham & Dillon, 1974) and lower levels of production blocking due to the improved coordination of member contributions (Bond & Shui, 1997). Based on previous research and the theoretical model depicted in Figure 1; the following predictions were made regarding openness:

> *H1*: The block of group process variables will mediate the relationship between a group's mean openness score and the quality and quantity of ideas produced while engaged in an interactive brainstorming task. Specifically, it is predicted that higher levels of openness will lead to lower levels of process loss, which will result in higher quality and quantity of ideas.

Emotional Stability

Research also supports the proposed linkages between emotional stability, group processes, and group outcomes. For example, Camacho and Paulus (1995) found that groups with higher mean emotional stability outperformed less emotionally stable brainstorming groups. Groups with higher levels of emotionally stability also have lower levels of social loafing (Jablin, 1981), feel less evaluation apprehension (Jablin, 1981), and have lower levels of production blocking (Furnham & Yazdanpanahi, 1995). Based on previous research and the theoretical model depicted in Figure 1, the following predictions were made regarding group-level emotional stability:

H2: The block of group process variables will mediate the relationship between a group's mean emotional stability score and the quality and quantity of ideas produced while engaged in an interactive brainstorming task. Specifically, it is predicted that higher mean emotional stability will lead to lower levels of process loss, which will result in higher quality and quantity of ideas.

Extraversion

Finally, research generally supports the proposed linkages between extraversion, group processes, and group outcomes. According to Bouchard (1969; 1972), groups with higher mean extraversion scores have more resources at their disposal but are susceptible to social loafing. In addition, Bradshaw, Stasson, and Alexander (1999) showed that even one introverted group member results in lowered productivity and increased evaluation apprehension. In light of this evidence and the model depicted in Figure 1, the following predictions were made:

H3: The block of group process variables will mediate the relationship between a group's mean extraversion score and the quality and quantity of ideas produced while engaged in an interactive brainstorming task. Specifically, it is predicted that higher mean extraversion scores will result in lower levels of process loss, which will result in higher quality and quantity of ideas.

METHOD

Participants

Participants were 312 undergraduate psychology students who received course credit in exchange for their time. Participants were randomly placed into 78 four-person groups without controlling for gender or ethnicity. In three groups, one group member either stopped participating before the end of the experimental session or did not provide useable data, thereby reducing the number of group members to three and the total sample size to 309. All group-level analyses were run twice, once with the 3 three-person groups excluded (N = 75) and once with them included (N = 78). The differences between the runs were negligible, and only the results using the total sample of groups (N = 78) are reported here. Sixty-nine percent (N = 214) of the participants were female, and the average age of the participants was approximately 19 years, 3 months.

Measures

NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992)
The NEO-FFI was used to measure three personality dimensions: Openness, Extraversion, and Emotional Stability. Each personality scale has 12 items. Responses are made on a 5-point scale ranging from (1) strongly disagree to (5) strongly agree. Previous research has shown the NEO-FFI to be a valid and reliable measure of personality traits.

Group Processes
Three scales were developed for this study to measure the group process variables: social loafing, evaluation apprehension, and production blocking. Items for each scale were taken from previous research when possible, but many new items were also added. These items were administered to each of the 309 participants during the course of this study. Responses were made on a 5-point Likert scale that ranged from strongly agree to strongly disagree. The resulting data were then subjected to an iterative series of principal components analyses until only one factor with an eigenvalue greater than 1.0 remained for each scale. At each iterative step of a series, items with factor loadings less than .60 on the first principal component were deleted, and the analysis was re-run with the smaller set of items.

The production blocking scale originally consisted of 12 items. After deleting five items with small factor loadings, a single-factor solution emerged that explained 49.50% of the variance (eigenvalue = 3.47). The 7-item production blocking scale also had a high internal consistency coefficient (alpha = .82, see Appendix A for a list of items).

The social loafing scale originally consisted of 13 items. After deleting five items due to insufficient factor loadings, a single-factor solution emerged that explained 45.62% of the variance (eigenvalue = 3.65). The 8-item social loafing scale also had a high internal consistency coefficient (alpha = .82, see Appendix A for a list of items).

The evaluation apprehension scale originally consisted of 11 items. After deleting four items due to insufficient factor loadings, a single-factor solution emerged that explained 49.74% of the variance (eigenvalue = 3.48). The 7-item evaluation apprehension scale also had a high internal consistency coefficient (alpha = .82, see Appendix A for a list of items).

Composite scores on each of the process variables were computed for each of the individual participants as a unit-weighted sum of the retained items. Each participant received two scores for each process variable, one for each brainstorming session in which they participated.

Group level scores on each process variable were computed by averaging the scores of all group members for each brainstorming session.

Group Outcomes

Each group generated ideas on three topics that were always administered in the same order: (1) What are some uses for a brick? (2) How can the campus community be improved for students? (3) How would things be different if everyone suddenly had a second thumb? The first topic was used during a warm-up practice session to acquaint participants with brainstorming procedures. The remaining two topics served as the focus of the subsequent group brainstorming sessions.

To determine the number of unique ideas generated in each session, a coder who was blind to the hypotheses eliminated the redundant ideas within each session for each group. Each session was then assigned a quantity score based on a count of the non-redundant ideas that were generated in that particular brainstorming session.

The following procedures (adapted from Barki & Pinsonneault, 2001) were used to determine the quality of ideas generated in each session. First, two questionnaires were developed, one for each idea generation topic. The questionnaires consisted of a list of all the unique ideas generated by all groups for each topic. For each unique idea on the "How can the campus community be improved for students?" questionnaire, two raters assessed three facets of quality using a 7-point Likert-type scale (1 = very low and 7 = very high): the idea's originality, feasibility, and effectiveness. For each unique idea on the "How would things be different if everybody suddenly had a second thumb on each hand?" questionnaire, raters assessed the idea's importance and practicality using a five-point scale (1 = impractical or unimportant and 5=very practical or very important). The questionnaires were administered to two raters who were familiar with the brainstorming topics but were blind to the hypotheses. The Task 1 (How can the campus community be improved for students?) quality ratings showed evidence of strong interrater reliability, R_{wg} = .99 (see James, Demaree, & Wolf, 1984). R_{wg} provides an index of the size of the variance in actual ratings relative to the amount of variance expected in the ratings if they were random. The Task 2 (How would things be different if everybody suddenly had a second thumb on each hand?) quality ratings also showed evidence of strong interrater reliability, R_{wg} = .99. A quality score was calculated for each unique idea by averaging its quality ratings across raters. Three different measures of idea quality were then generated for each session using these ratings: total quality, mean quality, and good ideas. Good Ideas was calculated by counting the number of ideas having a quality score that is higher than the overall average quality score of all the unique ideas generated for that particular topic.

Design and Procedures

Each session was identically structured and conducted by a facilitator who was unaware of the research hypotheses being investigated; precise instructions were provided regarding how to conduct each session. When each group members arrived at the study site, the facilitator introduced the study and asked participants to sign a consent form, to provide demographic information, and to complete the NEO-FFI before being given further instructions. After the group members completed these items, the facilitator gave instruction on the rules of brainstorming, described how the sessions would unfold, and answered any questions. The participants were also provided with written brainstorming instructions and rules (Bouchard & Hare, 1970). Next, each group completed a 3-minute brainstorming session using the practice topic and recording their ideas on a large flipchart using markers that were provided for that purpose. Then, each group went on to the next brainstorming topic and generated ideas for 10 minutes, completed the Task 1 process measures, went on to the final brainstorming topic, and completed the Task 2 process measures.

RESULTS

Descriptive Statistics

Descriptive statistics are reported in Table 1 for all individual-level variables. The table shows the means, standard deviations, internal consistency, and inter-correlations for all variables. All of the internal consistency coefficients were over .70, and the internal consistency coefficients for the process measures were all over .80.

After examining the individual-level data, group-level personality and process scores were computed. For the sake of completeness, multiple group-level personality scores were created for each group by calculating the mean individual score, the variance of individual scores, the minimum individual score, and the maximum individual score. Before computing group-level process scores, the interrater reliabilities of the process measures were assessed to determine the appropriateness of aggregating individual ratings of group process to a group-level score. The mean interrater reliability index (Rwg; see James et al., 1984) for the 78 groups on the social loafing scale was .93 for Task 1 and .93 for Task 2. The mean interrater reliability index for the evaluation apprehension scale was .96 for Task 1 and .96 for Task 2. The mean interrater reliability index for the production blocking scale was .96 for Task 1 and .96 for Task 2. Altogether, the individual process variable ratings had a high degree of interrater reliability and were considered acceptable for

Table 1
Individual-Level Correlations

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. Production Blocking T1	12.30	3.22	.82										
2. Social Loafing T1	16.55	4.40	.65	.83									
3. Evaluation Apprehension T1	11.70	3.18	.78	.62	.82								
4. Production Blocking T2	12.41	3.06	.67	.47	.64	.83							
5. Social Loafing T2	16.79	4.47	.44	.56	.47	.62	.82						
6. Evaluation Apprehension T2	12.14	3.27	.57	.39	.61	.83	.57	.83					
7. Openness	39.12	5.79	−.10	−.08	−.10	−.05	−.11	−.09	.72				
8. Conscientiousness	44.20	5.86	−.18	−.19	−.22	−.15	−.11	−.11	−.13	.82			
9. Extraversion	43.00	5.58	−.26	−.38	−.31	−.25	−.28	−.23	−.00	.15	.75		
10. Agreeableness	43.55	5.43	−.14	−.21	−.22	−.10	−.15	−.12	−.01	.21	.27	.70	
11. Emotional Stability	38.93	7.32	−.10	−.08	−.12	−.07	−.03	−.06	−.06	.34	.22	.28	.83

Note: Listwise N = 302. The values on the diagonal are Cronbach's Alpha. Correlations with an absolute value of .12 or larger are significant at $p < .05$; correlations with an absolute value of .15 or larger are significant at $p < .01$.

aggregation to the group level (James et al., 1984). Group-level process scores were computed both for Tasks 1 and 2 by averaging the scores of all group members.

In addition, group-level outcome scores such as quantity, total quality, mean quality, and good ideas were computed for Tasks 1 and 2 for each group using the procedures outlined in the methods section. The raw number of ideas generated for the "campus" problem was 1348. Deleting the redundant ideas from the list revealed that 183 unique ideas were generated for the "campus" problem. The raw number of ideas generated for the "thumbs" problem was 1184. Deleting the redundant ideas from this list revealed that 156 unique ideas were generated for the "thumbs" problem. Diagnostic tests suggested that all variables met the assumptions necessary to proceed with further analysis. The inter-correlations among the group-level variables are shown in Tables 2, 3, and 4.

Inferential Statistics

Hypotheses 1 through 3 all predict that the process variables will mediate the relationship between group-level personality traits and outcomes. To test the mediation hypotheses, the procedures recommended by Baron and Kenney (1986) were followed. Hypothesis 1

Table 2
Inter-Correlations Among Group-Level Personality Measures

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Openness																			
1. Mean	1.0																		
2. Variance	.32	1.0																	
3. Minimum	.66	−.37	1.0																
4. Maximum	.81	.72	.35	1.0															
Conscientiousness																			
5. Mean	−.01	−.19	.06	−.14	1.0														
6. Variance	.05	.13	−.00	.14	−.17	1.0													
7. Minimum	−.03	−.19	.05	−.16	.76	−.71	1.0												
8. Maximum	.06	−.07	.07	−.01	.74	.45	.29	1.0											
Extraversion																			
9. Mean	.07	.04	.02	.04	.06	−.14	.13	−.01	1.0										
10. Variance	.09	.11	.02	.10	.01	.19	−.11	.11	−.05	1.0									
11. Minimum	.02	−.05	.04	−.03	.11	−.23	.23	−.02	.79	−.60	1.0								
12. Maximum	.11	.07	.04	.08	.13	.02	.09	.14	.78	.54	.33	1.0							
Agreeableness																			
13. Mean	.04	.09	−.06	.00	.18	−.02	.13	.14	.30	−.05	.29	.23	1.0						
14. Variance	−.07	.06	−.12	.00	.16	.13	.00	.17	.20	−.22	.26	.04	.03	1.0					
15. Minimum	.07	.03	.02	−.00	−.03	−.11	.07	−.06	.08	.08	.06	.13	.65	−.66	1.0				
16. Maximum	−.02	.11	−.13	.00	.15	−.00	.08	.10	.37	−.18	.40	.22	.75	.59	.20	1.0			
Emotional Stability																			
17. Mean	−.05	−.19	.07	−.16	.28	−.09	.26	.19	.26	−.18	.31	.12	.29	.05	.15	.22	1.0		
18. Variance	.16	.15	.04	.20	−.01	.19	−.12	.10	.00	.08	−.05	.05	.11	.26	−.18	.14	−.06	1.0	
19. Minimum	−.10	−.27	.11	−.23	.20	−.22	.30	.07	.12	−.19	.23	.02	.15	−.21	.28	.04	.78	−.61	1.0
20. Maximum	.11	−.08	.14	.02	.22	−.04	.20	.19	.13	−.11	.17	.07	.27	.09	.07	.19	.73	.55	.30

Note: N = 78. Correlations with an absolute value of .23 or larger are significant at $p < .05$; Correlations with an absolute value of .30 or larger are significant at $p < .01$.

Table 3
Correlations with Group Process Variables

Variable	Production Blocking		Social Loafing		Evaluation Apprehension	
	T1	T2	T1	T2	T1	T2
Openness						
1. Mean	−.08	−.11	−.17	−.18	−.11	−.15
2. Variance	−.04	−.01	.02	.04	.00	−.02
3. Minimum	−.06	−.11	−.13	−.14	−.09	−.13
4. Maximum	−.03	−.03	−.04	−.01	−.01	−.06
Conscientiousness						
5. Mean	−.13	−.20	−.17	−.27	−.23	−.22
6. Variance	.12	.02	.12	.14	.07	−.05
7. Minimum	−.18	−.15	−.22	−.28	−.21	−.12
8. Maximum	−.07	−.16	−.12	−.16	−.16	−.20
Extraversion						
9. Mean	−.46	−.44	−.52	−.48	−.50	−.45
10. Variance	−.03	−.11	.01	−.12	−.05	−.10
11. Minimum	−.37	−.30	−.47	−.36	−.40	−.33
12. Maximum	−.42	−.45	−.45	−.49	−.47	−.45
Agreeableness						
13. Mean	−.24	−.15	−.32	−.31	−.22	−.19
14. Variance	−.04	−.02	.01	−.07	.08	.03
15. Minimum	−.12	−.04	−.23	−.15	−.16	−.11
16. Maximum	−.21	−.09	−.25	−.26	−.10	−.11
Emotional Stability						
17. Mean	−.08	−.00	−.06	−.05	−.05	−.03
18. Variance	.04	−.01	.10	−.05	.16	−.02
19. Minimum	−.09	−.00	−.13	−.01	−.15	−.04
20. Maximum	−.04	−.01	.02	−.04	.05	−.06
Process Measures						
21. Production Blocking T1	1.0	.82	.72	.67	.86	.76
22. Social Loafing T1	.72	.61	1.0	.77	.72	.60
23. Evaluation Apprehension T1	.86	.82	.72	.65	1.0	.83
24. Production Blocking T2	.82	1.0	.61	.69	.82	.89
25. Social Loafing T2	.67	.69	.77	1.0	.65	.68
26. Evaluation Apprehension T2	.76	.89	.60	.68	.83	1.0

Note: N = 78. Correlations with an absolute value of .23 or larger are significant at $p < .05$; correlations with an absolute value of .30 or larger are significant at $p < .01$.

predicted that the process variables would mediate the relationships between mean openness and group outcomes. None of the relationships between mean openness and group outcome variables were statistically significant for Task 1. However, for Task 2, mean openness had

Table 4
Group-Level Correlations with Outcome Measures

Variable	Quantity of Ideas		Total Quality		Mean Quality		Good Ideas	
	T1	T2	T1	T2	T1	T2	T1	T2
1. Quantity of Ideas T1	1.0	.53	.99	.50	−.37	−.20	.75	.43
2. Total Quality T1	.99	.51	1.0	.48	−.24	−.20	.83	.42
3. Mean Quality T1	−.37	−.22	−.24	−.22	1.0	.07	.24	−.20
4. Good Ideas T1	.75	.40	.83	.38	.24	−.13	1.0	.33
5. Quantity of Ideas T2	.53	1.0	.51	.97	−.22	−.28	.40	.90
6. Total Quality T2	.50	.97	.48	1.0	−.22	−.04	.38	.96
7. Mean Quality T2	−.20	−.28	−.20	−.04	.07	1.0	−.13	.06
8. Good Ideas T2	.43	.90	.42	.96	−.20	.06	.33	1.0
5. Production Blocking T1	.03	−.13	.04	−.12	.04	.14	.05	−.12
6. Social Loafing T1	−.03	−.21	−.01	−.20	.10	.10	.04	−.22
7. Evaluation Apprehension T1	−.04	−.23	−.03	−.24	.02	.07	−.01	−.25
8. Production Blocking T2	−.10	−.23	−.09	−.22	.10	.13	−.07	−.23
9. Social Loafing T2	−.12	−.31	−.10	−.32	.12	.08	−.03	−.36
10.Evaluation ApprehensionT2	−.12	−.29	−.12	−.26	.05	.22	−.10	−.26
Openness								
11. Mean	.18	.37	.16	.39	−.16	−.02	.07	.39
12. Variance	.01	.02	.02	.00	.06	−.02	.03	−.02
13. Minimum	.18	.35	.16	.36	−.21	−.04	.06	.37
14. Maximum	.14	.25	.13	.25	−.09	−.03	.08	.23
Conscientiousness								
15. Mean	.08	−.02	.05	−.01	−.29	.00	−.12	.03
16. Variance	.02	.08	.03	.03	−.01	−.22	.05	−.01
17. Minimum	.06	−.05	.03	−.01	−.22	.13	−.11	.05
18. Maximum	.11	.03	.07	.01	−.27	−.12	−.05	.03
Extraversion								
19. Mean	.01	.10	.03	.06	.11	−.24	.05	.03
20. Variance	.17	.09	.21	.09	.17	−.00	.27	.10
21. Minimum	−.09	.05	−.11	.01	−.08	−.18	−.15	−.02
22. Maximum	.10	.14	.12	.11	.11	−.18	.15	.11
Agreeableness								
23. Mean	−.16	.09	−.17	.09	−.00	−.06	−.20	.09
24. Variance	−.11	−.11	−.13	−.13	−.11	−.09	−.16	−.11
25. Minimum	−.02	.12	−.01	.14	.06	.06	−.01	.11
26. Maximum	−.16	.04	−.18	.04	−.04	−.05	−.21	.02
Emotional Stability								
27. Mean	−.05	−.08	−.08	−.12	−.18	−.15	−.23	−.15
28. Variance	.04	.11	.03	.08	−.06	−.17	.02	.06
29. Minimum	.00	−.05	−.02	−.06	−.16	.00	−.15	−.06
30. Maximum	.04	.10	.02	.06	−.22	−.20	−.13	.02

Note: N = 78. Correlations with an absolute value of .23 or larger are significant at p < .05; correlations with an absolute value of .30 or larger are significant at p < .01.

significant relationships with quantity (*Multiple R* = .37, *p* < .01), total quality (*Multiple R* = .39, *p* < .01), and good ideas (*Multiple R* = .39, *p* < .01). However, the relationship between mean openness and the block of process variables for Task 2 was not significant (*Multiple R* = .20, *p* > .05). Altogether, the results of the mediated regression analysis for hypothesis 1 suggest that mean openness has strong relationships with group outcomes for Task 2, but these relationships are independent of the group process variables measured in the current study. Hypothesis 1 was not supported (see Table 5).

Hypothesis 2 predicted that process variables would mediate the relationships between Mean Emotional Stability and group outcomes. Only the relationship between mean emotional stability and good ideas for Task 1 was statistically significant (*Multiple R* = .23, *p* < .05). However, the relationship between mean emotional stability and the block of process variables for Task 1 was not statistically significant (*Multiple R* = .09, *p* > .05). These results indicate that mean emotional stability did not predict the group process variables and only predicted one group outcome. Hypothesis 2 was not supported (see Table 5).

Hypothesis 3 predicted that process variables would mediate the relationships between mean extraversion and group outcomes. Only the relationship between mean extraversion and mean quality for Task 2 was statistically significant (*Multiple R*=.24, *p*<.05). The relationship between mean extraversion and the block of process variables for Task 2 was also statistically significant (*Multiple R*=.51, *p*<.001). However, the relationship between the block of Task 2 process variables and mean quality for Task 2 was not statistically significant. In other words, mean extraversion predicted group processes and mean quality for Task 2, but the relationship between mean extraversion and mean quality for Task 2 was not mediated by the process variables. Hypothesis 3 was not supported (see Table 5).

DISCUSSION

Findings

Many of the relationships predicted by the hypothetical model depicted in Figure 1 were not supported. The expected relationships among Task 1 processes and Task 1 outcomes did not materialize. Although the results were in the predicted direction, mean openness and mean emotional stability did not have any significant relationships with the process variables. Also, mean extraversion only had one significant relationship with a group outcome variable. As a result, none of the

Table 5
Results of Mediated-Regression Analyses

Input Variable	Quantity		Total Quality		Mean Quality		Good Ideas	
	T1	T2	T1	T2	T1	T2	T1	T2
Mean Openness								
Step 1: Personality-Outcome	.18	.37**	.16	.39**	.16	.02	.07	.39**
Step 2: Personality-Process		.20		.20				.20
Step 3: Process-Outcome when controlling for Personality								
Step 4: Personality-Outcome is reduced or eliminated when controlling for Process								
Mean Emotional Stability								
Step 1: Personality-Outcome	.05	.08	.08	.12	.18	.15	.23*	.15
Step 2: Personality-Process							.09	
Step 3: Process-Outcome when controlling for Personality								
Step 4: Personality-Outcome is reduced or eliminated when controlling for Process								
Mean Extraversion								
Step 1: Personality-Outcome	.01	.10	.03	.06	.11	.24*	.05	.03
Step 2: Personality-Process						.51**		
Step 3: Process-Outcome when controlling for Personality						.09		
Step 4: Personality-Outcome is reduced or eliminated when controlling for Process								

$N = 78$. All values are multiple correlations. *$p < .05$; **$p < .01$.

hypotheses were supported. No support was found for the mediation of personality-outcome relationships by group processes.

Although none of the hypotheses were supported, several findings are still worth noting. For example, the high correlations among the individual-level personality and process variables suggest that some people are predisposed to view group processes negatively. Undependable, introverted, and disagreeable group members tended to rate group processes more negatively than their dependable, extraverted, and agreeable counterparts. One possible explanation for this finding is that the process measures collected in this study might be overly subjective and overly self-referent (I felt like ...) rather than group-referent (Everyone in the group ...). Group members may have been rating their own subjective experiences in the group rather than rating the quality of the whole group's processes.

Also worth noting are the relationships among mean openness and the process and outcome variables. The significant relationships among mean openness and group outcomes for Task 2 were expected based on previous findings, but the lack of mean openness to outcome relationships for Task 1 is somewhat surprising. The most obvious difference between Task 1 and Task 2 is the brainstorming topic. Future researchers should examine the openness–outcome relationship under topics that vary systematically from one another, perhaps in terms of abstractness of the problem.

Contrary to expectations, mean emotional stability did not predict the group processes variables and only predicted one outcome variable. However, previous research has shown that emotional stability has an impact on brainstorming performance (Camacho & Paulus, 1995). The discrepancy between the current findings and previous research could be attributable to minor differences in the methodologies used.

The lack of significant relationships between mean extraversion and group outcomes also contradicts previous findings (Bouchard, 1969). One possible explanation for the discrepancy in findings lies in the lack of a strong incentive for high performance in the current study. Bouchard (1972) found that groups with high mean extraversion performed the best when they were highly motivated and performed the worst under low motivation conditions. On the other hand, groups with low mean extraversion were unaffected by the motivational manipulation.

Somewhat surprising was the lack of significant relationships between Task 1 processes and Task 1 outcomes. Brainstorming researchers have universally found that process losses occur in brainstorming groups and that these processes have an impact on group outcomes, so it is very unlikely that Task 1 processes did not impact group outcomes. A more likely scenario is that the self-report process surveys were inadequate measures of group processes for Task 1. The stronger relationships

between processes and outcomes for Task 2 could stem from group members' exposure to the process measures for Task 1. Perhaps group members were sensitized to the group process constructs by the Task 1 measures.

Future Directions

Future research should examine the influence of other variables that were not the focus in the current study. For example, conscientiousness and agreeableness exhibited some statistically significant relationships with the process and outcome variables examined in the current study; follow-up studies should explore the role of these traits (see Waung & Brice, 1998) and other traits (Scudder & Herschel, 1994) in brainstorming groups. Conscientiousness, in particular, seems to have both an empirical and an intuitive link with social loafing. In addition, some authors have argued for the importance of other group outcomes including group satisfaction, participation, and cohesion (Kramer et al., 1997; Paulus, 2000; Scudder & Herschel, 1994; Van de Ven & Delbecq, 1974). Additional group processes such as cognitive stimulation and social facilitation might also play an important role in brainstorming groups (see Paulus, 2000). Finally, future research should examine the role that the brainstorming topic plays in determining group processes and outcomes.

Limitations

Many of the limitations of the current study have already been discussed in the context of interpreting findings and suggesting areas for future research, but several additional limitations are worth noting. First, the personality and process measures were collected from the same participants, which could result in same-source bias. Also, most of the group-level process scores were relatively low. The relatively low process scores suggest the possibility of range restriction in these measures, which could have attenuated any correlations. The size of the group could also play a role in determining the relationships among the variables in this study; previous research has shown that larger groups often experience more process loss (Paulus, 2000). Finally, the failure to find any mediation effects could be the result of low statistical power; a larger sample size may be needed to counteract this problem.

APPENDIX A

Appendix A: Process Measures

Production Blocking Items
  I felt I could speak up whenever I had something to say. (r)
  When I thought of an idea, I could express it immediately without have
  to wait. (r)
  I expressed my ideas soon after I thought of them. (r)
  I found it difficult to organize my ideas when working in a group.
  It was hard to know when it was my turn to talk.
  It was hard to concentrate on my own ideas while others in the group
  were talking.
  I felt like other members of the group listened to me. (r)
Evaluation Apprehension Items
  As a group, we listened to everyone's ideas. (r)
  As a group, we gave everyone's ideas fair consideration. (r)
  I was at ease during the idea generation sessions. (r)
  Some group members were very critical in their reaction to other's
  ideas.
  I wouldn't want my name attached to some of the ideas from my group.
  I kept thinking that other group members would criticize my ideas.
  I didn't express all of my ideas because I didn't want the members of my
  group to think I was weird or crazy.
Social Loafing Items
  I feel like I participated a great deal in the idea generation sessions. (r)
  I am satisfied with my own performance on this task. (r)
  I was very motivated to generate quality idea. (r)
  I really didn't take this task seriously.
  I didn't try very hard to help complete the group task.
  Working in a group helps me feel motivated. (r)
  Some people in this group did not carry their fair share of the overall
  workload.
  I didn't really care if my group succeeded in this task.

Note: (r)=reverse scored item.

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