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Does Generating Multiple Ideas Lead to Increased Creativity? A Comparison of Generating One Idea vs. Many

Roni Reiter-Palmon

Nicholas J. Arreola

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Roni Reiter-Palmon and Nicholas J. Arreola Department of Psychology, University of Nebraska–Omaha, Omaha, Nebraska, USA

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Recent findings in creativity research suggest that how creativity is operationalized may have a profound influence on theories of creative production. In this study, two paradigms—divergent thinking and creative problem solving—were compared on several indices of creativity while keeping the problem constant. Participants were students from a Midwestern University and received extra credit for participation. Ideas were rated for quality, originality, and elaboration, and compared across the 2 approaches. The results of this study indicated that participants that generated a single solution to a problem generated solutions of higher average and participant selected best quality, originality, and elaboration. Participants that generated multiple solutions generated more solutions and generated a highest rated solution for originality. These findings call attention to the need for researchers to more carefully consider the issue of measurement in creativity, and how asking participants to generate one solution or multiple solutions can affect interpretation and subsequent generalizations.

One important issue in studying creativity is how creativity is operationalized and measured. This issue has been at the forefront of creativity research from its early days, starting with Guildford's work on the structure of intellect (Guilford, 1967). The measurement of creativity is a nontrivial matter, as research findings related to creativity may be specific to the measure used (Plucker & Renzulli, 1999; Reiter-Palmon, Illies Young, Kobe, Buboltz, & Nimps, 2009). The measurement of creativity has taken on many forms, reflecting the different approaches to the study of creativity. Creativity measures can focus on creative personality (Treffinger & Selby, 2004), creative accomplishments (Carson, Peterson, & Higgins, 2005), creative behaviors (Kaufman, 2012), creative self-assessment (Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012), creative problem solving (Reiter-Palmon, Mumford, Boes, & Runco, 1997), divergent thinking (Runco, 1991), and the creative product (Amabile, 1996). Of these measures,

both measures of divergent thinking and creative problem solving are designed as measures of creative cognition (Leung et al., 2012).

However, there are important differences in the paradigms of divergent thinking and creative problem solving as creativity tasks. In the divergent thinking paradigm, the focus is solely on ideation, whereas creative problem solving tasks require participants to come up with one solution, so it includes ideation, as well as idea evaluation and selection (Cropley, 2006; Mumford, Mobley, Uhlman, Reiter-Palmon, & Doares, 1991). Traditional (i.e., nonrealistic) divergent thinking tasks, such as uses for a brick, present the individual with a solution, and the ideation focuses on finding as many problems as possible where bricks would be considered viable solutions (Cropley, 2013). In contrast, creative problem-solving tasks traditionally require the individual to generate a single solution to a problem. Using realistic problems in creative problem-solving tasks allows researchers to understand creativity as it applies to everyday situations and problems. However, not all divergent thinking tasks are nonrealistic. Divergent thinking in response to realistic problems has been found to be predictive of creativity (Okuda, Runco, & Berger, 1991). In addition, the use of familiar problems allows for the application of expertise, which is important for creativity (Vincent, Decker, & Mumford, 2002). However, others have suggested that the use of realistic stimuli may inhibit the originality of responses and increase the focus on utility or usefulness, due to a reliance on memory (Charles & Runco, 2001; Runco, Illies & Reiter-Palmon, 2005).

When realistic or *everyday* problems are presented as a divergent thinking task, they pose a problem that requires the individual to generate a breadth of solutions, as opposed to a single best or most creative solution, as in the case of everyday creative problem-solving tasks.

It appears that no research has directly compared solutions generated in response to a divergent thinking task (i.e., instructing individuals to generate multiple solutions) to a solution generated for the same problem, but presented as a creative problem-solving task (i.e., instructing individuals to generate a single solution). A direct comparison of these paradigms is important because both have been used as measures of creativity in research. In light of recent findings suggesting that what is known about creativity may be dependent upon how creativity is assessed (Reiter-Palmon et al., 2009), it important to understand if there are differences between the two approaches and if so, what is their nature.

One issue in making direct comparisons between these solutions is the scoring required. There has been much discussion and debate about how to score divergent thinking responses. Both types of responses, one solution or multiple solutions generated from a divergent thinking task, can be scored for quality, originality, and elaboration. However, because there are multiple solutions generated in the divergent thinking task, the decision of which value of quality, originality, and elaboration should be used is less clear. Multiple possible approaches can be used when multiple solutions are generated, such as the average score (across all solutions), participant-selected

best solution, proportion or number of solutions that are high on the specific rating, or the solution rated most high on a specific rating scale as indicated by independent raters, each with its own strengths and weaknesses (Runco & Mraz, 1992; Runco, Okuda, & Thurston, 1987; Silvia et al., 2008; Wallach & Kogan, 1965). Of these, proportion and number do not allow for a direct comparison between divergent thinking and creative problem-solving tasks, as there is no equivalent for that in a single solution.

It is likely that when participants are asked to generate multiple solutions to a complex problem, they break the problem into components and list potential solutions for each aspect of the problem separately, resulting in simpler and fragmented solutions. However, when participants are asked to generate one solution to the problem, they will be more likely to incorporate multiple components into the solution. Therefore

Hypothesis 1: Participants will generate more ideas when asked to generate multiple solutions compared to one solution.

Hypothesis 2: Participants will generate a solution that is more elaborate and of higher quality when asked to generate one solution compared to multiple solutions. However, when evaluating originality, it has been suggested that the generation of multiple solutions will result in the generation of more original ideas (Osburn & Mumford, 2006).

However, when generating multiple ideas participants typically generate multiple routine ideas.

Hypothesis 3: Participants who are instructed to generate multiple solutions will generate at least one solution that is higher in originality, as determined by independent raters, compared to participants who are instructed to generate one solution.

Hypothesis 4: Participants who are instructed to generate multiple solutions will generate solutions that are lower in originality when ratings of originality are averaged across the solution set compared to those who generate just one solution.

METHOD

Data Set 1–Divergent Thinking

Participants

The sample consisted of 187 participants, 133 women (71%) and 54 men (29%), with an average age of 24.16 (SD = 6.52), of which, 22.3% were freshmen, 24.5% were sophomores, 19.7% were juniors, and 25.5% were seniors in college; 8% identified as

other. Participants in this study received extra credit for their participation or participated in this study as a requirement for psychology classes.

Experimental Task and Ratings

Participants were given a problem depicting an organization that is facing personnel shortages and budget shortfalls and asked to generate as many solutions as they could to this problem, as well as to select their best solution. Solutions were counted to create a fluency score. To allow comparisons with the ratings of one solution (creative problem-solving task), each solution was also rated on quality, originality, and elaboration by three trained raters using a modified version of Amabile's (1996) consensual assessment technique (i.e., raters received training in advance). Interrater agreement measured by ICC (2) on first usage was .81 for quality, .87 for originality, and .92 for elaboration, which are acceptable values for research purposes (Shrout & Fleiss, 1979). There are multiple ways in which solution quality and originality can be operationalized (Reiter-Palmon et al., 2009). In this study, three specific measures were evaluated: average, subject-selected best, and highestrated solution for quality, originality, and elaboration. For average, ratings were averaged across all of the solutions generated by the participant separately for quality, originality, and elaboration. For subject-selected best, participants were asked to select the solution that they thought was their best. The ratings for this solution on quality, originality, and elaboration, were used as participant-selected best score. Finally, for highest rated, highest quality, originality, and elaboration rating for each participant was identified. These scores were used as the measure of highest rated solution.

Data Set 2–Creative Problem Solving

Participants

The sample consisted of 176 participants, 115 women (65%) and 59 men (34%) and two people who did not specify gender, with an average age of 21.97 (SD = 5.08), of which, 24.6% were freshmen, 23.5% were sophomores, 26.3% were juniors, and 19.6% were seniors in college; 2.2% identified as *other*. Participants in this study received extra credit for their participation or participated in this study as a requirement for psychology classes.

Experimental Task and Ratings

Participants were given the same problem as participants in data set 1, except they were instructed to generate either a creative or best solution (one solution) to the problem. Solutions were rated on quality and originality by four trained raters. Interrater agreement using ICC(2) was .86 for quality and .99 for originality. In addition, the number of different and distinct ideas within each solution was counted as a parallel measure to fluency. Interrater agreement for this rating was .96. Solutions were also rated for elaboration by three trained raters. Interrater agreement for this rating using ICC(2) was .87. These reliabilities were acceptable for research purposes (Shrout &

Fleiss, 1979). A comparison of the solutions based on whether participants were asked to generate the best or most creative idea found no differences in any of the ratings, so the two conditions were combined.

TABLE 1
Means, Standard Deviations, and Correlations Among Creativity Measures from Data Set 1

Measures	Mean	SD	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. Fluency	4.66	2.83	−.36**	−.23**	−0.08	−0.05	−.14*	.37**	−.22**	−0.05	−0.08
2. Average Quality	2.07	0.70		.80**	.85**	.12*	0.01	−.13*	.38**	.21**	.35**
3. Subject Selected Best Quality	2.34	0.87			.85**	0.10	−0.01	−0.07	.36**	.40**	.41**
4. Highest Rated Quality	2.62	0.81				0.08	0.01	−0.01	.36**	.30**	.44**
5. Average Originality	2.39	0.65					.71**	.75**	0.08	0.04	0.09
6. Subject Selected Best Originality	2.45	0.96						.50**	0.01	−0.04	0.00
7. Highest Rated Originality	3.27	0.99							0.00	0.04	0.07
8. Average Elaboration	2.49	0.88								.80**	.85**
9. Subject Selected Best Elaboration	2.81	1.10									.86**
10. Highest Rated Elaboration	3.18	0.93									

Note. $n = 187$. Correlations are one-tailed.
*$p < .05$, **$p < .01$.

RESULTS

Before testing the hypotheses, the two samples were compared to insure that gender, age, and GPA did not bias the results. Because the samples were taken from the same population (same university, similar timeframe) no differences were expected, which was supported by t-tests. Means, standard deviations, and correlations between the different conceptualizations of creativity for the first data set are presented in Table 1, whereas the same information for data set 2 is presented in Table 2.

Hypotheses were tested using t-tests to compare data from data set 1 and data set 2. Specifically, the type of instructions given to participants and their effect on solution creativity was of primary interest in these analyses. Results of the *t*-tests comparing instructions given to participants in data set 1 and data set 2 on solution creativity can be seen in Table 3. A difference in number of ideas generated in the two conditions was found ($t = 3.11$, $p = .002$). Not surprisingly, more ideas were generated when participants were asked to generate multiple ideas (DT condition; $M = 4.65$, $SD = .21$) compared to the one solution condition ($M = 3.77$, $SD = .19$), supporting Hypothesis 1.

TABLE 2
Means, Standard Deviations, and Correlations Among Creativity Measures from Data Set 2

Measures	*Mean*	*SD*	*2*	*3*	*4*
1. Fluency	3.77	2.44	.67**	.61**	.01
2. Quality	2.57	0.86		.47**	.12
3. Originality	2.85	1.05			.13
4. Elaboration	3.36	0.96			

Note. $n = 176$. Correlations are one-tailed.
*$p < .05$, **$p < .01$.

First, the solution quality, originality, and elaboration of the one solution was compared with average solution quality, originality, and elaboration for multiple solutions. For solution quality, a difference was found (t = 6.06, p = .00), with participants in the one solution condition generating higher quality solutions (M = 2.57, SD = .86) compared to the average quality in the multiple solutions conditions (M = 2.06, SD = .69), supporting hypothesis 2. For solution elaboration, a difference was found (t = 8.73, p = .00), with participants in the one solution condition generating more elaborate solutions on average (M = 3.36,SD = .97), compared to participants who generated multiple solutions condition (M = 2.49, SD = .88), again providing support for hypothesis 2. For solution originality, a difference was found (t = 5.07, p = .00), with participants in the one solution condition generating more original solutions (M = 2.85, SD = 1.05) compared to the average originality in the multiple solutions condition (M = 2.39, SD = .65), supporting hypothesis 4.

TABLE 3
The Results of t-Tests Comparing Participant Data Set 1 and Data Set 2 on Measures of Solution Creativity

Solution	*Data Set 1: Multiple Solutions Generated*		*Study 2: One Solution Generated*		*t-value*
	Mean	SD	Mean	SD	
Number of Ideas	4.65	2.83	3.77	2.44	3.11*
Average					
	Mean	SD	Mean	SD	
Quality	2.06	.69	2.57	.86	−.6.07**
Originality	2.39	.65	2.85	1.05	−5.07**
Elaboration	2.49	.88	3.36	.97	−8.73**
Subject Selected Best					
	Mean	SD	Mean	SD	
Quality	2.34	.87	2.57	.86	−2.44*
Originality	2.45	.96	3.02	1.07	−5.07**
Elaboration	2.81	1.10	3.36	.97	−4.81**
Highest Rated					
	Mean	SD	Mean	SD	
Quality	2.62	.80	2.57	.86	.61
Originality	3.27	.98	3.02	1.07	2.31*
Elaboration	3.18	.93	3.36	.97	−1.80

Note. *$p < .05$; **$p < .01$.

Comparisons using the subject selected best solution as the measure of quality, originality, and elaboration in the DT condition, indicated a difference for quality (t =2.44, p =.02). Participants in the one solution condition generated solutions higher in quality (M = 2.57, SD =.86) compared to those who provided multiple solutions (M = 2.34, SD = .87). For elaboration, a significant difference was found between the two conditions (t = 4.81, p = .00). Participants in the one solution condition generated more elaborate solutions (M = 3.36, SD = .97) compared to participants in the multiple solutions condition (M = 2.81, SD = 1.10). The findings for quality and elaboration provide support for hypothesis 2. Differences were also found for originality (t = 5.07, p = .00).

Participants in the one solution condition generated more original solutions (M = 3.02, SD = 1.07) compared to those that provided multiple solutions (M = 2.45, SD = .96). When evaluating quality, originality, and elaboration of the highest rated solution in the DT condition, there were no differences in quality or elaboration between the two conditions. For originality, a difference was found (t = 2.31, p =.02) such that participants who generated multiple solutions provided a more original solution (M = 3.27, SD = .98) compared to those who generated one solution (M = 3.02, SD = 1.07), supporting hypothesis 3.

DISCUSSION

The results of this study suggest that there are significant differences between the two approaches. Across the 10 different comparisons, generating one solution resulted in higher scores for six of the comparisons: for average (quality, originality, and elaboration) and participantselected best (quality, originality, and elaboration). Only fluency and highest-rated originality were higher for generating multiple ideas, compared with one solution. It is not surprising that more ideas (higher fluency) were generated when participants were asked to generate multiple solutions as participants tended to include simple and potentially low-quality solutions, as they focused on generating multiple solutions. In addition, the results of the study suggest that, indeed, when participants are asked to generate multiple ideas, they are more likely to generate at least one highly original idea (Osburn & Mumford, 2006).

Interestingly, although participants in the multiple idea generation condition were able to generate at least one idea that was more original than the ideas generated in the single idea condition (creative problem-solving task), this idea was rarely selected as the best idea by the participants. There are a number of reasons why this may be occurring. First, participants were told to select the best idea, and may not see originality as part of the definition of best for real world problems. When asked to select the best idea for a real-world problem, individuals may choose to focus on ideas that are less original and, therefore, less risky (Blair & Mumford, 2007). Second, real world problems may limit originality due to reliance on memory. As a result, participants may choose an idea that is tried and true, or was successful in the past and, therefore, not highly creative. Finally, individuals may be able to generate creative ideas, but are not necessarily good judges of those ideas (Silvia, 2008). However, it is also important to note that previous research suggests that participants are able to recognize original ideas (Runco & Chand, 1995; Runco & Vega, 1990). T

his study provides what appears to be the only direct comparison between two different approaches to assessing creativity, a divergent thinking model versus creative problem solving using the same task, and as such addresses an important question regarding similarities and differences across these approaches. This research may provide further guidance to researchers selecting a creativity task to serve as the dependent variable. One important difference between the two approaches is that the creative problem-solving task includes both divergent and convergent thought, however,

the divergent thinking task includes only divergent thought—these differences result in differences in outcomes such as fluency, quality, originality, and elaboration.

Additionally, this research contributes to the growing research that evaluates and compares different measures of creativity (Reiter-Palmon et al., 2009, 2011; Silvia et al., 2012). These studies all find that different measures of creativity may evaluate different aspects of the creative process and that different measures may have different patterns of relationships with other variables of interest (such as personality or contextual measures). As a result, the measurement of creativity is not always simple and straightforward. Instead, researchers and practitioners must be aware of the purpose for the measurement, its strengths and weaknesses, and then select a tool that fits that purpose. Specifically, the results of this study suggest that the choice between a divergent thinking framework and that of the creative problem-solving framework may depend on the purpose of the study. If the purpose is to evaluate fluency or identify one solution that is most original, the divergent thinking approach may be best. However, if the purpose is to focus on overall creativity, a combination of quality, originality, and elaboration, then the creative problem-solving approach may be best.

This study is not without its limitation. One issue is that the study used two different samples for comparison. Although both samples were taken from the same student population, potentially some differences may exist in sample characteristics that may influence the results beyond those directly examined. It is important to note that conducting the study as a within-subject design would have posed different issues, such as contamination (as the same problem needs to be used for both one solution generation and multiple solution generation). Another important limitation of this study is the use of only one problem, or one item. Therefore, it is possible the results may not generalize to other real-world problems. However, using one creative problem-solving exercise is not unusual in creativity research, as the task tends to be time consuming and effortful (Byrne, Shipman, & Mumford, 2010; Peterson et al., 2013; Reiter-Palmon et al., 2009).

This study also only focused on a direct comparison of these two approaches for evaluating creativity. More information may be gleaned by evaluating the differential effect of these two approaches on predicting other outcomes of interest, such as creative achievements, or evaluating whether other predictors of creativity, such as personality, differentially predict performance on these two tasks. That is, in regard to the latter point, the relationship between task instructions and creative performance may depend on the presence of certain personality traits.

Domain specificity may also play a role in determining which approach is more beneficial to creativity. Although participants generally generated solutions that were of higher quality and originality, and more elaborate when asked to generated one solution, there may be some domains in which generating multiple ideas is more conducive to creativity than generating just one idea. Future research should examine

whether certain domains are particularly susceptible to the differential effects of instructions.

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