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FORECASTING ERRORS IN CREATIVE PROBLEM-SOLVING: DELIBERATING ABOUT THE FUTURE

A DISSERTATION APPROVED FOR THE

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Abstract

There are a number of key processes involved in creative thought, giving rise to the potential for errors to occur. Error management training has been shown to be more effective than error avoidance, suggesting the need for research on error management in creative problem-solving. In the present effort, we examined the impact of forecasting timeframe, forecasting extensiveness, and deliberation on errors on creative problem-solving. This study asked 225 undergraduate participants to work through six scenarios, identify errors in those scenarios, and forecast and/or deliberate on those errors prior to completing a final marketing plan appraised for creativity. It was found the number of errors identified, number of positive and negative outcomes listed, specificity of forecasts and deliberations, and quality of forecasts and deliberations led to better creative solutions. The implications of these findings for understanding how people work with errors, specifically in creative problem-solving, are discussed.

Keywords: creative thought, errors, error management, forecasting

Introduction

Creative achievement is critical to the longevity and success of firms (Tushman and O'Reilly, 1997; Florida, 2002). Such achievement, however, calls for the production of new viable ideas (Mumford, Connelly, Scott, Espejo, Sohl, Hunter, & Bedell, 2005). The generation of these new ideas requires creative thought, or the production of original, high quality, and elegant solutions (Besemer and O'Quinn, 1999; Christiaans, 2002) in response to complex, novel, and ill-defined problems (Mumford & Gustafson, 2007). Given the complexities inherent to creative thinking, and the number of processes which go into developing a creative solution (Mumford, Mobley, Reiter-Palmon, Uhlman, & Doares, 1991), errors are likely to occur.

There is some evidence, based on the careers of creative people, that errors occur throughout the creative process (Pray, 2008; Kanigel, 2005). Findings by Martin, Elliott, and Mumford (2019), a study similar to the present effort, show how taking the time to think deeply about errors, or deliberate on errors, improves the originality of creative problem solutions. Still, more research is needed on the impact errors have on creative thought (Hammond, Farr, & Sherman, 2011). Given that forecasting, or the mental stimulation of future outcomes of ideas (Mumford, Lonergan, & Scott, 2002), prompts an individual to think ahead and consider multiple consequences to ideas, one might expect forecasting about errors to influence their potential impact on the creative thinking process.

Specifically, the extensiveness of forecasting and timeframe of forecasts have been shown to be positively related to the quality, originality, and elegance of creative solutions (Byrne, Shipman, & Mumford, 2010; Mumford, Schultz, & VanDoorn, 2001;

Lubart, 2001; Lonergan, Scott, & Mumford, 2004). However, little is known about how forecasting about errors influences the production of creative problem solutions. The purpose of this study is to investigate how forecasting about and deliberating on identified errors influences subsequent creative problem solutions. Specifically, this study seeks to explore how the extensiveness of forecasts and time frame of forecasts on identified errors impacts the quality, originality, and elegance of creative problem solutions. Additionally, this study not only seeks to investigate direct effects of forecasting and deliberation on creative problem solutions, but also if these effects are mediated by the processes in which people work with errors.

Errors

Failure is often defined differently by practitioners and considered to be context specific (Pinto & Covin, 1989) in that the factors which determine success or failure of a solution are specific to that solution's implementation process, perceived value, and client satisfaction (Pinto & Mantel, 1990). Failure may result from a number of factors (e.g., lack of information, miscommunication), but nonetheless is the consequence of an error. Errors can manifest in human performance through a variety of ways (Norman, 1984; Rasmussen, 1983), and are a result of an individual's action that leads to an undesirable gap between expected and actual performance (Zhau & Olivera, 2006). These actions may involve movement, habit, omission, recognition, memory, judgement, goal setting, mapping, inaccurate execution of a task, or inappropriate application of knowledge (Frese & Zapf, 1994; Rizzo, Bagnara, & Visciola, 1987).

Given the multitude of reasons that can lead to an error, it seems critical to understand how people identify errors in human performance. A study by Allwood

(1984) investigated how people identify errors in statistical problem-solving tasks. Think aloud protocols were used as people worked through these tasks. Findings show people were able to identify errors based on their knowledge of past experiences and recognition of undesirable results between expected and actual performance. People were able to identify errors through experience or analysis of performance, and better problem solutions were provided by those skilled at identifying errors.

Understanding error identification strategies given certain contextual parameters may be particularly important. Another study by Henneman, Gawlinski, Blank, Henneman, Jordan, and McKenzie (2010) sought to describe strategies used by critical care nurses to identify medical errors, subsequently employing effective patient care and safety protocols. Audio taped focus groups of critical care nurses from two community hospitals and two university medical centers were collected. Findings show eight key strategies for identifying errors within the context of nurse performance: 1) knowing the patient, 2) knowing the "players", 3) knowing the plan of care, 4) surveillance, 5) knowing policy/procedure, 6) double-checking, 7) using systematic processes, and 8) questioning. Utilizing these strategies, nurses were able to identify medical errors and ensure better patient care and safety. Given that errors arise when there is a discrepancy between expected and actual performance (Zhau & Olivera, 2006), it may be that strategies giving attention to the specific context and meaning of the discrepancy (e.g., knowing the patient, knowing the players) may be critical to ensuring effective problem solutions.

Relatedly, Cowan (1986) argues it may not just be the discrepancy that needs attention, but deliberation on the error and attempting to correct that error may be critical

for better problem solutions. In the nurses study, once an error was identified using one of the eight mentioned strategies, different strategies were taken to interrupt and correct those errors, resulting in improved patient care and safety. In fact, research shows that not only identifying errors is important, but error management is beneficial to performance rather than error avoidance (Dyck, Frese, Baer, & Sonnentag, 2005; Keith & Frese, 2005, 2008). Specifically, error management training transfer is found to be effective in contexts presenting novel, or ill-defined tasks (i.e., creative problems) resulting in better problem solutions (Keith & Frese, 2008).

Errors in Creativity

Creative problems are novel, complex, and ill-defined (Mumford & Gustafson, 2007), thus errors are likely to occur during the problem-solving process for various reasons, including biases, improper use of strategies (e.g., simplification strategies), and inadequate application of creative thinking processes (e.g., idea evaluation) (Mumford, Blair, Dailey, Lertiz, & Osburn, 2006; Mumford, et al., 1991). This being said, there is a need for more research on how errors manifest in creative problem solving activities. Initial evidence on errors in the idea evaluation process of creative thought has been provided by Blair and Mumford (2007). In this study, undergraduate students evaluated a list of ideas for funding a foundation and selected the ideas they thought were most appropriate.

Findings show people erroneously avoided ideas that were original, risky, and time consuming, even if these ideas were more likely to lead to creative problem solutions. Further evidence on people discounting original ideas during idea evaluation has been provided by Licuanan, Dailey, and Mumford (2007). In this study, however,

participants were less likely to erroneously discount original ideas if they were asked to actively analyze the idea. Evidence for errors in other key creative thinking processes can be found in the literature, particularly for conceptual combination, where participants made more errors depending on the framing of the task (Ward, Patterson, & Sifonis, 2004), and problem definition, where participants made more errors when focused on goals rather than constraints and procedures (Mumford, Baughman, Threlfall, Supinski, & Costanza, 1996).

Given existing evidence that errors occur in creative thought, it is critical to understand how people manage errors when working on creative problem-solving tasks. Robledo, Hester, Peterson, Barrett, Day, Hougen, and Mumford (2012) conducted a study where participants assumed the role of a principal at an experimental high school. They were asked to illustrate their mental models for understanding secondary schools, and then write plans for leading their school. Prior to illustrating their mental models, they were trained on error management strategies while working through four training modules including: 1) future consequences (think about errors that might happen in the future as a result of earlier error), 2) social consequences (think about how errors might effect different stakeholder groups), 3) controllability (think about whether an error would be under your control), and 4) criticality (think about how large an effect an error might have in attaining your objective). Findings provided from this study show participants had more original and more elegant problem solutions, and stronger mental models for conceptualizing the task, when they experienced error management training.

Thus, if people actively think about errors while working on a creative problem, it appears they will produce better creative solutions. Further evidence of this can be found

in a study similar to the present effort. Martin et. al. (2019) presented undergraduates with a series of ten marketing scenarios and ideas. They were subsequently asked to identify, deliberate, and/or remediate any errors they saw while evaluating these ideas, and then asked to write a marketing plan. It was found the number of errors identified and the quality of their suggestions on how to fix those errors were positively correlated with the quality, originality, and elegance of their plans. Additionally, those who deliberated on, or actively thought about, identified errors had more original problem solutions. Taken as a whole, these findings lead to our first hypothesis.

Hypothesis 1: *Identification of errors will be positively related to the production of creative problem solutions of higher originality, higher quality, and higher elegance.*

Identification of errors is a critical first step in managing them (Allwood, 1984; Henneman et. al., 2010) and forecasting their potential consequences, but initial evidence also shows people must think deeply about these errors (Martin et. al., 2019). Findings from the Martin et. al. (2019) study showed deliberation improved the originality, but hurt the elegance of plans. In another study by Marcy and Mumford (2007) undergraduates were asked to respond to six social innovation problems drawn from the business and educational domains. Participants engaged in causal analysis skill training and were asked to engage in deliberation by forecasting the downstream implications of their problem solutions and think about the implications of their solutions for stakeholders. Findings show causal analysis skills led to the production of more creative problem solutions, particularly for those participants asked to deliberate.

Deliberation on errors may cause people to consider multiple paths to a problem solution, increasing the complexity of problem-solving efforts subsequently hurting the

elegance of a creative solution (Martin et. al., 2019). That said, evidence still shows its positive impact on the originality of plans. Our second hypothesis states that deliberation on errors will lead to more original but less elegant problem solutions.

Hypothesis 2: Deliberation on identified errors will result in the production of creative problem solutions of higher originality, but less elegance.

Forecasting

Given that errors will occur throughout the creative thinking process, it is critical to identify strategies on managing these errors while working on a creative problem. The evidence mentioned thus far suggests identifying and actively thinking about errors will influence the production of more creative problem solutions, but more research is needed to understand how other processes known to contribute to creative problem-solving may play a role in error management. For example, forecasting, a cognitive activity involving the projection of downstream consequences of actions or ideas (Mumford et al., 2002), has been shown to benefit creative problem solutions (Shipman, Byrne, & Mumford, 2010; Byrne et. al., 2010; Marta, Leritz, & Mumford, 2005) and may prompt individuals to consider downstream consequences of errors they have identified, further influencing creative performance.

There is evidence that certain factors of forecasting contribute to creative performance. Byrne, Shipman, and Mumford (2010) asked undergraduates to assume the role of a mid-level manager responsible for writing an advertising campaign that would promote a new high-energy root beer. They received emails asking them to forecast the implications of their ideas, and the effects of their plan for implementing their ideas. Plans were evaluated for quality, originality, and elegance, and forecasts were evaluated

for 27 attributes, with extensiveness of the forecast as an emerging factor. Findings show more extensive forecasts led to plans of higher quality, originality, and elegance. The extensiveness of forecasts reflects a more detailed, comprehensive understanding of the problem and potential issues that may arise in problem-solving efforts. Thus, it may be that forecasting about errors in creative thinking may prompt people to consider a more comprehensive understanding of the consequences of those identified errors, and subsequently influence creative problem solutions. This notion leads to our third hypothesis.

Hypothesis 3: *Forecasting extensiveness on identified errors will result in the production of creative problem solutions of higher originality, higher quality, and higher elegance.*

In a similar study, Shipman, Byrne, and Mumford (2010) asked undergraduates to assume the role of a principal in an experimental secondary school. They were asked to write a plan for leading this school while receiving emails asking participants to forecast outcomes of their plans. Plans were appraised for quality, originality, and elegance, and forecasts were appraised for 21 forecasting attributes, of which both forecasting extensiveness and forecasting time frame were emerging factors. Findings are consistent with Byrne et. al. (2010) in that extensiveness of forecasts led to plans of higher quality, originality, and elegance. Additionally, findings show forecasting over a long time frame, as opposed to a short time frame, led to plans of higher quality, originality, and elegance. It may be that considering consequences further downstream, as opposed to just imminent consequences, may prompt people to consider long-lasting effects of errors

made, thus influencing creative performance. These findings lead to our fourth hypothesis.

Hypothesis 4: *Forecasting over a long time frame on identified errors will result in the production of creative problem solutions of higher originality, higher quality, and higher elegance.*

Working with Errors

Thus far, evidence has been provided to suggest not only identifying and deliberating on errors (Martin et al., 2019, Keith & Frese, 2005), but potentially forecasting about errors (Shipman et al., 2010; Byrne et al., 2010) may directly influence the quality, originality, and elegance of creative problem solutions. Of note, however, is the question if the effects on quality, originality, and elegance are direct, or mediated by the processes by which people work with those errors. In other words, are the ways in which people work with errors in their forecasts and deliberations mediating their effects on creative performance?

In Byrne et al. (2010), a factor that improved the quality, originality, and elegance of advertising campaigns was the forecasting of negative outcomes. In other words, when forecasting, participants who identified more negative outcomes produced better creative solutions. Additionally, Osburn and Mumford (2006) found that when participants were trained to forecast about negative outcomes, contingencies and restrictions, and long-term outcomes, creative performance improved. It may be that when people work with errors by specifically considering negative outcomes, they produce plans of higher quality, originality, and elegance.

Hypothesis 5: Considering more negative outcomes when working with errors will result in the production of creative problem solutions of higher originality, higher quality, and higher elegance.

Relatedly, considering positive outcomes has been shown to improve strategies that influence creative problem solving (Mulhearn, McIntosh, & Mumford, 2020). Mulhearn et al. (2020) asked participants to assume the role of a manager of a clothing company trying to enter a new market. Prior to formulating plans on expanding this company into a new market, participants were asked to analyze cases, make an outline of their plan, and forecast the implications of their plan. It was found that generation of positive outcomes improved forecasting, which subsequently improve the quality, originality, and elegance of problem solutions. Thus, it may be that when people consider more positive outcomes in working with errors, they will subsequently produce better creative solutions.

Hypothesis 6: Considering more positive outcomes when working with errors will result in the production of creative problem solutions of higher originality, higher quality, and higher elegance.

Additionally, the specificity or generality by which people work with errors may influence creative problem solutions. Ward et al. (2004) manipulated instructions of a task priming participants to think more abstractly or more specifically while generating ideas. It was found that specificity hurt the novelty of problem solutions in that it constrained the formation of a new idea compared to those who thought more abstractly. That said, it is argued that greater specificity of information when engaging in strategies used to improve creative problem-solving (i.e., propulsion strategies) (Mecca &

Mumford, 2014), could expedite the problem-solving process and thus improve subsequent creative problem solutions (Ward et al., 2004). It may be that being more specific when engaging in error management strategies, by working with and thinking about errors in greater detail, will lead to higher quality, more original, and more elegant problem solutions.

Hypothesis 7: Greater specificity when working with errors will result in the production of creative problem solutions of higher originality, higher quality, and higher elegance.

Finally, it may be that when people are more complete and coherent when working with errors, considering more appropriate ways to address those errors, they may produce better creative problem solutions. When deliberating on errors, people may consider multiple paths to a problem solution. Likewise, when forecasting about errors, people are likely to consider multiple downstream consequences of those errors. Considering more complete, coherent, and useful paths and consequences when working with identified errors may influence creative performance. Thus, when engaging in error management strategies, people who provide higher quality responses, or who are more through when working with those errors may subsequently produce better creative solutions.

Hypothesis 8: Participants who produce higher quality responses when working with errors will result in the production of creative problem solutions of higher originality, higher quality, and higher elegance.

Method

Sample

The participants in this study included 225 undergraduates from a large southwestern university. Participants were recruited via an online recruiting platform and received extra credit for participating. They were provided a brief description of the studies available online and selected the study in which they wanted to participate. There were 35.1% males and 64.9% females, with an average age of 18.81 years and an average GPA of 3.58. Academic ability for these participants lay a quarter standard deviation above freshmen enrolling at four-year institutions.

General Procedures

This two-hour study is similar to the one conducted in Martin, et. al. (2019), with a few changes, including the administration of this study being completely online via Qualtrics. Participants were asked to participate in a study where they would engage in problem-solving at a fictious marketing firm. The first twenty minutes involved a set of timed covariate controls. The remainder of this study allowed participants to work at their own pace completing an experimental task and a series of untimed covariate measures. The experimental task took about seventy minutes to complete, and the untimed covariate measures took half an hour. Upon completion of the study, participants were presented a debriefing form and awarded credit.

The experimental task was adapted from Gibson and Mumford (2013). Participants were presented with a novel, complex, ill-defined creative problem-solving task and asked to assume the role of a mid-level manager at a specialty apparel firm. They were presented with a description of the firm, including the company's history, and

told their task is to review a series of marketing scenarios and develop a marketing campaign to help expand the firm into the southern market. Participants were also presented with marketing research about the firm, including information about their customers, competitors, their brand recognition, the location of the company, and information on other companies their customers like to shop. Next, they were presented with an email from the senior vice president instructing them to review a series of six marketing scenarios accompanied by ideas submitted from other marketing managers. Participants reviewed the ideas and responded to a series of questions presented with each scenario. Each scenario asked participants to provide a one or two sentence summary of the scenario and identify errors in the other manager's ideas. They were then presented with a second email from the senior vice president and asked to reflect on the errors they identified before writing a final marketing campaign to expand the specialty apparel firm into the southern market. Judges appraised these plans for quality, originality, and elegance (Besemer & O'Quin, 1999; Christiaans, 2002).

Participants were asked to summarize each scenario in one or two sentences and identify any errors in the ideas submitted by other marketing managers. Participants were then asked additional probe questions, depending on their randomly assigned condition, asking them to forecast any short-term or long-term outcomes the errors may cause, to forecast any and all possible situations and outcomes that may occur from the errors, and/or to deliberate, or think more deeply about one of the errors they identified and write a paragraph describing how they would manage that error. Half of the scenarios presented had errors embedded in them, half did not have embedded errors. These errors were drawn from prior research on marketing errors by Korte (2003), and the scenarios

alternated from one with embedded errors to one without. Written answers to these questions were appraised by trained judges to evaluate their performance on the identification of errors, deliberation on those identified errors, the timeframe of forecasts, and the extensiveness of forecasts.

Control Measures

The set of timed covariate control measures involved measures of intelligence and divergent thinking. The intelligence test was the verbal reasoning measure drawn from the Employee Aptitude Survey. This measure included 30 items and presented a set of facts bearing on a problem, asking participants to indicate "true", "false", or "uncertain". This measure produces retest reliabilities above .80. Evidence for this test as a measure of intelligence has been shown by Grimsley, Ruch, Warren, and Ford (1985) and Ruch and Ruch (1980). Divergent thinking was assessed using Merrifield, Guilford, Christensen, and Frick's (1962) consequences measure. Participants were presented with five questions about unlikely scenarios (e.g., What would be the consequences if people no longer wanted or needed to sleep?) and asked to list as many consequences as they possibly can under a ten-minute time limit. The measure is scored for fluency (i.e., the number of consequences listed) and yields internal consistency coefficients above .70. Merrifield et al. (1962) and Vincent, Decker, and Mumford (2002) provide validity evidence for the use of this measure.

The set of untimed covariate controls involved a measure of demographics, marketing expertise, a task-specific knowledge test, and measures of planning skills, need for cognition, and personality. The marketing expertise measure was drawn from Gibson and Mumford (2013). This measure presents background information questions

(Mumford & Owens, 1987) inquiring about past involvement in marketing activities. Questions include “How often have you discussed current advertisements with your friends” and “How often have you thought about how you could make advertisements better”. Participants responded on a self-report, 5-point scale indicating how often they engaged in that activity. Internal consistency coefficients for this measure are about .70. Gibson and Mumford (2013) provide validity evidence for this measure of marketing expertise. The task-specific knowledge test was used to assess participant’s knowledge of the firm and asked them five questions including “What type of merchandise does Charamousse sell” and “Where are Charamousse’s operations primarily based”. Internal consistency coefficients for this measure are above .70. Given that the questions were written for this specific task, evidence is provided for the content validity of this measure.

Planning skill was measured using Marta, Lertiz, and Mumford’s (2005) measure of planning skills. Participants are presented with business scenarios and asked to respond to five questions assessing key planning skills (e.g., identification of downstream consequences). Each question presented a list of 6 to 12 potential responses, and asked participants to select 3 to 4 as their answers. These responses were scored for application of relevant planning skills in response to the scenario. Split-half reliability coefficients are in the .80s, and Marta, Leritz, and Mumford (2005) provide evidence for the construct and predictive validity of this measure.

Given that the experimental task was novel, complex, and ill-defined, it required participants to invest some degree of cognitive resources. Thus, participants were asked to complete Cacioppo and Petty’s (1982) need for cognition scale where they responded to a series of 18-items assessing engagement in cognitive actives. Example items include

"I prefer complex to simple problems" and "I prefer my life to be filled with problems I must solve". Using a 5-point scale, participants indicate to what degree they agree or disagree with these statements. Internal consistency coefficients for this scale are about .80, with evidence for predictive validity provided by Marcy and Mumford (2007) and Osburn and Mumford (2006). The final untimed covariate measure was an assessment of personality using Costa and McCrae's (1989) NEO Five Factor inventory measure of openness, neuroticism, agreeableness, conscientiousness, and extraversion. This measure presents a series of 60 items including "I am not a worrier" and "I like to have a lot of people around me" and asked participants to respond on a 5-point scale how much they agree or disagree with those statements.

Experimental Task

The experimental task in this study asked participants to assume the role of a mid-level marketing manager at a specialty apparel firm called Charamousse. Participants were first presented with general instructions stating they need to read through information on the company's background, customer base, and work environment, proceed to review a series of six scenarios accompanied by ideas submitted by other marketing managers, and finally write a campaign to expand the firm into the southern market. After these instructions, participants went on to read about the history of the firm. This paragraph informed participants that the firm had been founded in 1998 with the purpose of selling original clothing using sustainable production practices. Each shirt was original in that only a certain number of each product was produced and sold in stores, thus ensuring customers had a unique product. Participants were told that Charamousse had 14 stores across the Midwest located in renovated spaces. The firm owner,

Montogmery Foster, saw that the firm's growth had stopped in 2019 and sought to expand its operations into a new, southern market. At this point the participant is told it is their job to help in this process by reviewing marketing ideas and create a final campaign to expand into the new market.

Participants are then presented with a page of marketing research for the firm. This marketing research included information about the customers, competitors, and the company's environment. Participants were told customers on average were extroverted young adults who spend a lot of money on clothes. The firm's brand is recognized in the Midwest, but not the south. Competitors were primarily high-end designer clothing firms. Charamousse's customers tended to be college graduates earning about $60,000 a year and enjoyed yoga. Firms similar to Charamousse include Apple, drinks made by Odwalla, and hybrid cars. This market research summary can be seen in Figure one.

Insert Figure 1 here

Participants then proceeded to the next page where they received an email from the senior vice president, Colleen Anderson, requesting that they review a series of six marketing scenarios with ideas submitted by other managers. Participants were instructed to "identify any solution-related errors you see in the proposed marketing ideas". Depending on their randomly assigned condition, participants were also asked to "describe the short-term/long-term outcomes of those errors", "describe any other potential outcomes that may result from those errors", and "elaborate on how you would manage those errors". Participants were reminded they will be responsible for writing a

final marketing campaign to help Charamousse enter the southern market, and then proceeded to an attachment from this email providing an overview of errors. This overview provided a definition of what an error was and might look like in the following scenarios. This attachment can be seen in Figure two.

Insert Figure 2 here

Next, participants were presented with six marketing scenarios accompanied by ideas submitted by other marketing managers. Scenarios were presented in a fixed order across all conditions, and participants were asked to provide a one to two sentence summary of each scenario. Each scenario was about three to four sentences long and contained three ideas, each a sentence long, for how to take action in that scenario. Scenarios could be a team's sales resulted in employee prizes, or a special event was planned and ideas were needed to attract both new and old customers. Three scenarios had embedded errors, three did not, and scenarios alternated between having errors and not having errors. Errors were based on prior marketing research by Korte (2003) including: 1) missing important causes, 2) unrealistic expectations of success, 3) failing to recognize complex interdependencies, 4) overlooking important alternatives, 5) selective information gathering, and 6) subjective information processing. A scenario with embedded errors is provided in Figure three.

Insert Figure 3 here

After reviewing these marketing scenarios, participants received a second email from Colleen Anderson and were instructed to begin the final marketing campaign to help Charamousse enter the southern market. Participants moved on from this email to answer the final prompt which stated "Take a moment to reflect on the errors you identified and their outcomes. Please create a final marketing campaign to help us enter the southern market."

Design and Manipulation

This was a 2x2x2 study design. Manipulations included probe questions for forecasting timeframe, forecasting extensiveness, and deliberation, and were presented in this fixed order depending on condition, respectively. In the control condition, participants were just asked to provide a one to two sentence summary of the scenario they read, and were asked to identify any solution-related errors they saw while reading through the ideas ("please list the errors you identified in the scenario in the space below"). In all other conditions, participants were then asked additional questions asking them to forecast about the outcomes of those errors, or deliberate more on an error they identified. In the forecasting timeframe condition, participants were asked to either "Please consider the errors you identified in the above scenario and list the short-term outcomes these errors may cause" or "Please consider the errors you identified in the above scenario and list the long-term outcomes these errors may cause". In the forecasting extensiveness condition, participants were asked to "Please consider the errors you identified in the above scenario and write a paragraph about possible outcomes that may occur. Please consider any and all possible situations and outcomes that may occur from the errors". In the deliberation condition, participants were asked to "Please

think more about one of the errors you identified and write a paragraph describing how you would manage this error".

Dependent Variables

After reviewing the six scenarios presenting various marketing ideas, participants then moved on to the final task asking them to reflect on identified errors and write a final marketing plan to help the firm enter a new market. These plans were appraised by trained judges for key attributes of creative problem solutions, quality, originality, and elegance, according to Besemer and O'Quin (1999) and Christiaans (2002). Benchmark rating scales were used to appraise these plans given their use provides greater reliability and accuracy of evaluating creative products (Redmond, Mumford, and Teach, 1993). Quality was defined as a complete, coherent, and workable solution. Originality was defined as an unexpected well-elaborated solution. Elegance was defined as a refined clever solution where solution elements fit together seamlessly. Judges rated a set of sample marketing plans for these three variables. Based on these sample ratings, plans were identified that represented low, mid, and high points of each scale with little to no disagreement across judges. These were then used to provide scale anchors. An example rating scale is provided in Figure four.

Insert Figure 4 here

Three doctoral students were the judges asked to appraise marketing plans using these rating scales. These students were familiar with both the marketing and creativity literature domains. Judges first met for an hour-long frame of reference training session

where they got familiar with the experimental task and operational definitions of variables needing to be applied to the plans. Judges then rated a set of marketing plans, and met again to discuss differences in their evaluation of marketing plans. During these consensus meetings, judges clarified procedures for applying their ratings to these plans in terms of quality, originality, and elegance. Training was effective in that interrater agreement coefficients were .82, .79, and .76 for evaluating quality, originality, and elegance after meeting to clarify rating procedures.

These judges also appraised written responses from the six marketing scenarios with respect to errors. Specifically, judges were asked to count the number of errors identified, and the number of positive and negative outcomes listed in their forecasts and deliberations of errors. They were also asked to rate the quality and specificity of their forecasts and deliberations of errors. Specificity was defined as the degree to which responses address larger problems vs. specific issues. Quality was defined as a complete, coherent, and useful response when working with an error. Interrater agreement coefficients were .86 and .85 for specificity and quality, respectively. Intraclass correlation coefficients are provided for the number of errors identified, the number of positive outcomes, and number of negative outcomes as .99, .91, and .97 respectively.

Analyses

The first set of analyses looked at correlations between our creativity dependent variables, quality, originality, and elegance, with our covariates and rated error variables (e.g., number of errors identified, number of positive and negative outcomes, specificity of response, quality of response). In the second set of analyses, analysis of covariance tests were conducted to observe direct effects of our manipulations on quality, originality,

and elegance. Covariates were included in the ANCOVAs if they were significant at the .10 level. The third set of analyses included another set of analysis of covariance tests looking at how our manipulations influenced the quality, originality, and elegance of plans. A median split was then conducted on these scenario variables in order to conduct a fourth set of analyses, another series of analysis of covariance tests looking at these variables on quality, originality, and elegance. Our analyses took an approach similar to Marta et al. (2005), looking at how the number of identified errors, number of positive and negative outcomes, and the quality and specificity of responses while working with errors mediated the effects of our manipulations on the quality, originality, and elegance of plans.

Results

Table 1 displays correlations for quality, originality, and elegance with our covariates. All three are strongly correlated with intelligence, divergent thinking, and the knowledge test. Table 2 presents correlations for quality, originality, and elegance on our rated scenario variables. As can be seen, the number of errors identified was positively correlated with quality (r = .44), originality (r = .36), and elegance (r = .42). The number of positive outcomes listed was positively correlated with quality (r = .24), originality (r = .23), and elegance (r = .23). The number of negative outcomes listed was positively correlated with quality (r = .30), originality (r = .25), and elegance (r = .30). Specificity was positively correlated with quality (r = .52), originality (r = .42), and elegance (r = .50). Finally, quality of scenario responses was positively correlated with quality (r = .54), originality (r = .44), and elegance (r = .52).

Insert Table 1 here

Insert Table 2 here

Table 3 displays ANCOVA results for our manipulations on quality, originality, and elegance. For quality, the knowledge test ($F(1, 214) = 11.60$, $p \leq 0.01$) and intelligence ($F(1, 214) = 15.68$, $p \leq 0.01$) were significant covariates. No significant effects from our manipulations were found for plan quality. When looking at originality, knowledge test ($F(1, 214) = 10.62$, $p \leq 0.01$) and divergent thinking ($F(1, 214) = 7.66$, $p \leq 0.01$) were significant covariates. No manipulation effects were found on plan originality. For elegance, knowledge test ($F(1, 214) = 13.12$, $p \leq 0.01$) and intelligence ($F(1, 214) = 10.29$, $p \leq 0.01$) were significant covariates. As with quality and originality, no manipulation effects were found for plan elegance.

Insert Table 3 here

Table 4 displays ANCOVA results for our manipulations on our rated scenario variables. For number of errors identified, knowledge test ($F(1, 213) = 8.12$, $p \leq 0.01$), divergent thinking ($F(1, 213) = 12.06$, $p \leq 0.01$), and openness ($F(1, 213) = 4.63$, $p \leq 0.05$) were significant covariates. No effects from our manipulations were found on the number of errors identified. For number of positive outcomes, main effects were found

for the deliberation manipulation ($F (1, 191) = 48.21$, $p \leq 0.01$), and an interaction effect was found with deliberation and extensiveness ($F (1, 191) = 21.37$, $p \leq 0.01$). When participants were instructed to deliberate on the errors they identified, they listed more positive outcomes ($M = .41$, $SD = .02$) than those not asked to deliberate ($M = .18$, $SD = .02$). And, for deliberation and forecasting extensiveness, participants listed more positive outcomes ($M = .48$, $SD = .03$) when asked to deliberate but not forecast extensively, compared to those in neither condition ($M = .09$, $SD = .03$), those asked just to forecast extensively ($M = .26$, $SD = .03$), and those asked to do both ($M = .34$, $SD = .03$). Still, those asked to deliberate and forecast extensively had more positive outcomes listed than those asked just to forecast or those in neither condition.

For the number of negative outcomes listed, divergent thinking was a significant covariate ($F (1, 191) = 12.20$, $p \leq 0.01$). Main effects for deliberation ($F (1, 191) = 49.16$, $p \leq 0.01$) and extensiveness ($F (1, 191) = 9.29$, $p \leq 0.01$) were found. Those asked to deliberate produced less negative outcomes ($M = .95$, $SD = .06$) than those not asked ($M = 1.52$, $SD = .06$). Those asked to forecast extensively produced more negative outcomes ($M = 1.36$, $SD = .06$) than those not asked ($M = 1.11$, $SD = .06$).

For specificity, knowledge test ($F (1, 190) = 15.71$, $p \leq 0.01$) and divergent thinking ($F (1, 190) = 6.94$, $p \leq 0.01$) were significant covariates. Main effects for timeframe ($F (1, 190) = 4.84$, $p \leq 0.05$) and extensiveness ($F (1, 190) = 4.04$, $p \leq 0.05$) were found. When participants were asked to consider more short term outcomes, they were less specific ($M = 2.27$, $SD = .06$) compared to those asked to consider long term outcomes ($M = 2.44$, $SD = .06$). When participants were asked to forecast extensively, they were more specific ($M = 2.44$, $SD = .06$) compared to those not asked ($M = 2.27$, SD

= .06). Additionally an interaction between deliberation and extensiveness (F (1, 190) = 4.80, $p \leq 0.05$) was found. Those asked to deliberate but not forecast extensively were more specific (*M* = 2.40, *SD* = .08) than those not asked to forecast or deliberate (*M* = 2.15, *SD* = .08). When asked to forecast extensively and deliberate, participants were less specific (*M* = 2.38, *SD* = .08) than when asked to forecast but not deliberate (*M* = 2.49, *SD* = .08).

For quality, knowledge test (F (1, 190) = 21.38, $p \leq 0.01$) and divergent thinking (F (1, 190) = 6.96, $p \leq 0.01$) were significant covariates. Main effects for timeframe (F (1, 190) = 3.80, $p \leq 0.05$) and extensiveness (F (1, 190) = 4.63, $p \leq 0.05$) were found. Those asked to forecast short term produced less quality responses (*M* = 2.18, *SD* = .06) compared to those asked to forecast long term (*M* = 2.33, *SD* = .06). Those asked to forecast extensively produced higher quality (*M* = 2.34, *SD* = .06) response compared to those not asked (*M* = 2.17, *SD* = .06). Additionally, an interaction between extensiveness and deliberation was found (F (1, 190) = 4.41, $p \leq 0.05$). Those asked to forecast extensively and deliberate on errors produced less quality response (*M* = 2.28, *SD* = .08) compared to those asked to forecast extensively but not deliberate (*M* = 2.41, *SD* = .08). Those asked to deliberate but not forecast extensively produced higher quality responses (*M* = 2.27, *SD* = .08) compared to those not asked to forecast or deliberate (*M* = 2.07, *SD* = .08).

Insert Table 4 here

Table 5 displays ANCOVA results for our scenarios rated variables on quality, originality, and elegance. Median splits were conducted on number of errors identified, number of positive outcomes, number of negative outcomes, specificity, and quality. For quality, knowledge test ($F(1, 196) = 4.12$, $p \leq 0.05$) and intelligence ($F(1, 196) = 13.84$, $p \leq 0.01$) were significant covariates. A main effect ($F(1, 196) = 13.73$, $p \leq 0.01$) was found for number of errors identified in that when more errors were identified, higher quality plans ($M = 2.75$, $SD = .08$) were produced compared to when fewer errors were identified ($M = 2.33$, $SD = .08$). Similar results were found for originality in that there was a significant main effect ($F(1, 196) = 6.33$, $p \leq 0.05$) where those who identified more errors produced more original plans ($M = 2.09$, $SD = .07$) than those who identified fewer error ($M = 1.83$, $SD = .07$). Knowledge test ($F(1, 196) = 6.83$, $p \leq 0.05$) and divergent thinking ($F(1, 196) = 4.21$, $p \leq 0.05$) were significant covariates. For elegance, knowledge test ($F(1, 196) = 5.24$, $p \leq 0.05$) and intelligence ($F(1, 196) = 10.42$, $p \leq 0.01$) were significant covariates. A main effect was found for the number of errors identified ($F(1, 196) = 12.18$, $p \leq 0.05$) in that those who identified more produced more elegant plans ($M = 2.81$, $SD = .07$) than those who identified less errors ($M = 2.43$, $SD = .08$).

When looking at number of positive outcomes on quality, knowledge test ($F(1, 196) = 7.77$, $p \leq 0.05$) and intelligence ($F(1, 196) = 14.38$, $p \leq 0.05$) were significant covariates. There was a main effect ($F(1, 196) = 5.04$, $p \leq 0.05$) in that those who identified more positive outcomes had higher quality plans ($M = 2.68$, $SD = .08$) compared to those who identified fewer positive outcomes ($M = 2.43$, $SD = .08$). For originality, knowledge test ($F(1, 196) = 9.71$, $p \leq 0.05$) and divergent thinking (F (1,

196) = 6.53, $p \leq 0.05$) were significant covariates. A main effect for number of positive outcomes was found (F (1, 196) = 4.46, $p \leq 0.05$) in that those who identified more produced more original plans (*M* = 2.07, *SD* = .07) compared to those who identified fewer positive outcomes (*M* = 1.87, *SD* = .07). For elegance, knowledge test (F (1, 196) = 9.06, $p \leq 0.05$) and intelligence (F (1, 196) = 10.97, $p \leq 0.05$) were significant covariates. A main effect was found (F (1, 196) = 5.45, $p \leq 0.05$) in that those who identified more positive outcomes produced more elegant solutions (*M* = 2.75, *SD* = .08) compared to those who identified fewer positive outcomes (*M* = 2.50, *SD* = .08).

For negative outcomes on quality, knowledge test (F (1, 196) = 6.53, $p \leq 0.05$) and intelligence (F (1, 196) = 12.34, $p \leq 0.05$) were significant covariates. A main effect was found (F (1, 196) = 9.54, $p \leq 0.05$) in that those who listed more negative outcomes had higher quality plans (*M* = 2.72, *SD* = .08) compared to those who listed fewer (*M* = 2.37, *SD* = .08). For originality, knowledge test (F (1, 196) = 7.94, $p \leq 0.05$) and divergent thinking (F (1, 196) = 6.33, $p \leq 0.05$) were significant covariates. A main effect (F (1, 196) = 6.96, $p \leq 0.05$) was found in that those who listed more negative outcomes had more original plans (*M* = 2.10, *SD* = .07) compared to those who listed fewer (*M* = 1.84, *SD* = .07). For elegance, knowledge test (F (1, 196) = 7.66, $p \leq 0.05$) and intelligence (F (1, 196) = 9.11, $p \leq 0.05$) were significant covariates. A main effect was found (F (1, 196) = 10.72, $p \leq 0.05$) and shows those who listed more negative outcomes had more elegant plans (*M* = 2.80, *SD* = .08) compared to those who listed fewer negative outcomes (*M* = 2.45, *SD* = .08).

For specificity on quality, knowledge test (F (1, 196) = 5.66, $p \leq 0.05$) and intelligence (F (1, 196) = 12.09, $p \leq 0.05$) were significant covariates. A significant main

effect was found (F (1, 196) = 18.37, $p \leq 0.05$) in that those who were more specific had higher quality plans (*M* = 2.78, *SD* = .08) compared to those who were not as specific (*M* = 2.31, *SD* = .08). For originality, knowledge test (F (1, 196) = 7.70, $p \leq 0.05$) and divergent thinking (F (1, 196) = 5.21, $p \leq 0.05$) were significant covariates. A main effect was found (F (1, 196) = 8.09, $p \leq 0.05$) in that those who were more specific provided mor original plans (*M* = 2.10, *SD* = .07) compared to those who were less specific (*M* = 1.82, *SD* = .07). For elegance, knowledge test (F (1, 196) = 7.00, $p \leq 0.05$) and intelligence (F (1, 196) = 9.03, $p \leq 0.05$) were significant covariates. A main effect (F (1, 196) = 14.19, $p \leq 0.05$) was found in that those who were more specific provided more elegant plans (*M* = 2.82, *SD* = .07) compared to those less specific (*M* = 2.42, *SD* = .08).

Finally, for quality of working with errors on plan quality, knowledge test (F (1, 196) = 4.21, $p \leq 0.05$) and intelligence (F (1, 196) = 12.00, $p \leq 0.05$) were significant covariates. A significant main effect was found (F (1, 196) = 22.78, $p \leq 0.05$) in that those who wrote better quality responses provided higher quality plans (*M* = 2.81, *SD* = .08) compared to those who provided less quality responses (*M* = 2.28, *SD* = .08). For originality, knowledge test (F (1, 196) = 5.85, $p \leq 0.05$) and divergent thinking (F (1, 196) = 4.82, $p \leq 0.05$) were significant covariates. A main effect was found (F (1, 196) = 14.95, $p \leq 0.05$) in that those who wrote better quality responses provided more original plans (*M* = 2.16, *SD* = .07) compared to those who provided less quality responses (*M* = 1.77, *SD* = .07). And, for elegance, knowledge test (F (1, 196) = 5.26, $p \leq 0.05$) and intelligence (F (1, 196) = 8.81, $p \leq 0.05$) were significant covariates. A main effect (F (1, 196) = 21.71, $p \leq 0.05$) was found in that those who wrote better quality responses

provided more elegant plans (M = 2.81, SD = .07) compared to those who provided less quality responses (M = 2.38, SD = .08).

Insert Table 5 here

Discussion

Limitations should be addressed before turning to the findings and implications of this study. First, this study was based on an experimental paradigm with undergraduate students, thus the generalizability of results to real world settings is questionable. Error management strategies employed by undergraduates in a lab setting may be different than strategies employed in the real world, particularly by those with more marketing expertise. And, it may be that undergraduates are not as good at identifying errors in marketing scenarios as those with more marketing expertise. It should be noted that our knowledge test was a significant covariate in most analyses, thus it is likely that expertise accounts for differences in performance not only in error management, but error management in creative problem-solving. This knowledge test was a task specific measure, not a general knowledge measure.

Second, participants were instructed to identify errors prior to responding to our manipulations – consider short-term or long-term outcomes of those errors (e.g., forecasting timeframe), consider any and all possible consequences of those errors (e.g., forecasting extensiveness), and deliberate on those errors. In other words, forecasting and deliberations were with respect to errors identified from marketing scenarios prior to moving on to the final task. Thus, results from this study are valuable with respect to

errors, or how people work with errors, and not necessarily on creative problem-solving in general (Lonergan et al., 2004).

Third, manipulations were presented in a fixed order. Participants identified errors, and were then presented with forecasting timeframe, forecasting extensiveness, and deliberation manipulation prompts, respectively. Findings could be different if manipulations were presented in a different order. For example, if participants were asked to deliberate on errors they identified prior to forecasting about their consequences, forecasts might consider more or different consequences and thus influence subsequent creative problem solutions.

Fourth, this study was based on a low fidelity marketing exercise (Motowidlo, Dunnette, & Carter, 1990). It is worth noting that there is prior evidence provided by Gibson and Mumford (2013) that this clothing exercise is appropriate for studying creative problem-solving in lab settings. Still, it is a low-fidelity simulation and maximizing real-world creative problem solving may produce different findings. Fifth, the body of research on error management in creative problem-solving is limited. Even considering initial evidence on this topic (Martin et al., 2019; Robledo et al., 2012; Licuanan et al., 2007), much more research is needed to understand how people work with errors while engaging in creative problem-solving efforts. The present effort attempts to add to the literature in exploring how people work with errors through forecasting and deliberating on identified errors in a marketing task.

Of note are differences between the Martin et al. (2019) study and the present effort. Rather than ten scenarios, only six were used. This was meant to lessen the cognitive burden on participants as they identified, forecasted, and deliberated on errors

for each scenario. Additionally, the scenarios with embedded errors were alternated with scenarios without embedded errors – the Martin et al. (2019) study presented scenarios with errors as the first set of five scenarios, and without errors as the last set of five scenarios. Alternating scenarios with errors embedded and not embedded should help control for potential bias and extraneous factors as participants worked through the experimental task. Finally, the present effort was conducted completely online via Qualtrics rather than a lab setting – a result of the COVID-19 pandemic. Findings may differ from that of Martin et al. (2019) given participants completed the task in their own setting and on their own personal devices.

Bearing these limitations in mind, the present study has some noteworthy implications, particularly with regard to how people work with errors on a creative problem-solving task. Our first hypothesis was supported in that the number of errors identified would be positively related to the quality, originality, and elegance of plans. When people are instructed to identify errors prior to engaging in a creative task, they eliminate non-viable solution paths that may otherwise be considered, and thus produce plans of higher quality, originality, and elegance (Martin et al., 2019).

Turning to our manipulations, it can be seen that our second, third, and fourth hypotheses are not supported in that there are no direct effects on the quality, originality, and elegance of plans. Of note, however, is the effects of our knowledge test and intelligence on the quality and elegance of plans, along with the effects seen from our knowledge test and divergent thinking on the originality of plans. Specifically, forecasting timeframe, forecasting extensiveness, and deliberation had no impact on the quality, originality, and elegance of marketing plans when considering intelligence,

divergent thinking, and task expertise. People can think about short term or long term outcomes of errors, consider any and all possible outcomes of errors, and thinking deeply on errors, but this does not appear to influence creative performance when intelligence, divergent thinking, and knowledge are considered. Of particular note is the knowledge test, which had an effect on all three aspects of our creativity variables – quality, originality, and elegance. It appears task expertise is particularly important when working with errors and influences subsequent creative problem solutions.

Although our manipulations didn't work directly on the creativity of our plans, results show that our manipulations did in fact have effects on the number of positive outcomes listed, the number of negative outcomes listed, the specificity of forecasts and deliberations on errors, and the quality of forecasts and deliberations on errors. But, first, although the number of errors identified was not seen to be directly impacted by our manipulations, it is of note that participants were asked to identify errors prior to responding to our manipulation prompts – thus, errors had to be identified before they could be forecasted or deliberated on by participants. And, as stated previously, along with initial evidence provided in the literature (Martin et al., 2019), the number of errors identified on is positively related to the quality, originality, and elegance of plans, suggesting the identification of more errors is beneficial to the production of more creative problem solutions.

With this in mind, it is of note that people identified more positive outcomes when asked to deliberate on errors identified. Additionally, when people were asked to both forecast extensively about errors and deliberate on errors, more positive outcomes were listed, specifically from those who were just asked to deliberate. Thus, it appears

when people are asked to consider many potential outcomes of errors, and to think deeply on those errors, they consider more positive outcomes when working with those errors. Interestingly, more negative outcomes were listed by participants who were asked to forecast extensively about errors, however, fewer negative outcomes were listed by those asked to deliberate on those errors. Thus, when people are asked to consider multiple consequences of an error, they consider more negative outcomes as opposed to when they are asked to think deeply on those errors. Taken as a whole, it appears deliberating on errors leads to consideration of more positive, but less negative outcomes. Forecasting extensively on those errors, however, leads to more negative outcomes, unless also asked to think deeply about those errors.

The level of specificity, or how general vs specific one is when working with errors, was impacted by forecasting timeframe and extensiveness. Specifically, those asked to consider more long-term consequences were more specific in their forecasts and deliberations about errors. Likewise, those asked to consider any and all possible outcomes were more specific when working with errors. Thus, it appears forecasting about errors leads people to be more specific, considering long term consequences and outcomes of greater detail, when working with errors. Along similar lines, results for the quality of forecasts and deliberations on errors was impacted by forecasting timeframe and forecasting extensiveness. Those who considered more long-term forecasts, and forecasted more extensively, produced higher quality responses when working with errors.

Given the evidence thus far, it appears our manipulations have effects on the way people work with errors. The next question, however, is how might the way people work

with errors differentially impact subsequent creative problem solutions? First, not only was the number of errors identified positively correlated with creativity, but analysis of covariance test results showed people produced plans of greater quality, originality, and elegance when they identified more errors, even when considering knowledge, divergent thinking, and intelligence.

Our fifth and sixth hypotheses were supported in that the number of negative outcomes and positive outcomes listed contributed to plans of greater quality, originality, and elegance, even considering knowledge, intelligence, and divergent thinking. Thus, when people work with errors and list more negative and positive outcomes, they produce more creative plans. Our seventh hypothesis was supported given when participants were more specific in their forecasts and deliberations on errors, they produced plans of higher quality, originality, and elegance. Findings are the same for when people provided higher quality forecasts and deliberations, supporting our eighth hypothesis. Thus, when people are more specific and provide better quality forecasts and deliberations when working with errors, they, in turn, produce more creative problem solutions.

In conclusion, forecasting timeframe, forecasting extensiveness, and deliberation on errors do not seem to contribute to creative problem solutions when considering knowledge, intelligence, and divergent thinking. That said, they do contribute to how people work with errors on a creative problem task, in that people list more positive and negative outcomes, and are more specific, providing higher quality forecasts and deliberations when thinking about errors they've identified. And, when people are better at working with errors through listing more positive and negative outcomes, providing more detailed and higher quality forecasts and deliberations, they produce higher quality,

more original, and more elegant creative problem solutions. Thus, people can consider more short or long term, more extensive outcomes of errors, and deliberate on errors, but creativity will not benefit simply by forecasting or deliberating on errors - what is critical to creative performance is how people work with those errors. Forecasting more extensively, more long-term, and deliberating on errors seems to make people better at working with errors, and when people are better at working with errors, they produce higher quality, more original, and more elegant problem solutions.

Errors will occur in the creative thinking process (Mumford et al., 1991), and there is evidence that people make errors when engaging in creative tasks (Licuanan et al., 2007; Ward et al., 2004; Mumford et al., 1996). More research is needed on how people identify and work with errors in creative problem-solving, especially as it pertains to deliberating on errors and forecasting about those errors. These findings have implications for error management training (Keith & Frese, 2005, 2008; Robledo et al., 2012) in creative efforts, in that the focus of training should be on how people identify and work with errors. As people are trained on identifying and working with errors, they should in turn become better at managing errors and subsequently produce better creative problem solutions.

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Table 1.
Correlations for creativity and covariates

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Quality	2.53	0.85	1													
2. Originality	1.96	0.73	.747**	1												
3. Elegance	2.62	0.81	.929**	.762**	1											
4. Intelligence	6.79	7.57.	.333**	.189**	.295**	1										
5. Divergent Think	6.12	2.4	.228**	.252**	.218**	.092	1									
6. Knowledge Test	3.84	1.16	.314**	.283**	.318**	.334**	.258**	1								
7. Planning	8.97	1.9	.181**	.060	.180**	.189**	-.040	.250**	1							
8. Need for Cog	3.13	0.59	.164*	.092	.169*	.209**	.203**	.245**	.216**	1						
9. Marketing Exp	14.4	4.5	-.028	.075	-.015	-.219**	.082	.010	-.158*	.060	1					
10. Neur	3.24	0.66	-.037	-.116	-.047	.021	-.095	-.002	-.014	-.195**	-.012	1				
11. Extra	3.55	0.66	-.055	.013	-.037	-.216**	.093	-.066	-.098	.107	.139*	-.162*	1			
12. Open	3.21	0.52	.067	-.011	.057	.199**	.088	.224**	.212**	.519**	-.021	-.058	.108	1		
13. Agree	3.53	0.53	-.035	-.069	.017	.011	.016	.126	.133*	.044	-.032	-.051	.301**	.174**	1	
14. Consc	3.62	0.58	.077	.019	.116	-.016	.043	.076	.053	.256**	.042	-.333**	.292**	.090	.264**	1

Note: ** sig. at .01 level
* sig. at .05 level

Table 2.
Correlations for creativity and rated scenario variables

	M	SD	1	2	3	4	5	6	7	8
1. Quality	2.53	0.85	1							
2. Originality	1.96	0.73	.747**	1						
3. Elegance	2.62	0.81	.929**	.762**	1					
4. Number of Errors ID	1.5	0.74	.435**	.363**	.416**	1				
5. Number of Positive Outcomes	0.29	0.27	.240**	.232**	.234**	.248**	1			
6. Number of Negative Outcomes	1.23	0.66	.297**	.249**	.304**	.658**	-0.083	1		
7. Specificity	2.35	0.61	.520**	.424**	.502**	.651**	.493**	.559**	1	
8. Quality (Scenario)	2.26	0.61	.533**	.438**	.519**	.691**	.477**	.630**	.975**	1

Note: ** sig. at .01 level

* sig. at .05 level

Table 3.
ANCOVA Results for manipulations on quality, originality, and elegance

Source	*SS*	*df*	*MS*	*F*	*p*	η_p^2
Quality						
Knowledge Test	7.21	1	7.21	11.60	0.00**	0.05
Intelligence	9.75	1	9.75	15.68	0.00**	0.07
Timeframe	0.91	2	0.45	0.73	0.48	0.01
Extensiveness	0.10	1	0.10	0.16	0.69	0.00
Deliberation	0.22	1	0.22	0.35	0.55	0.00
Timeframe * Extensiveness	0.46	1	0.46	0.74	0.39	0.00
Timeframe * Deliberation	0.13	1	0.13	0.21	0.65	0.00
Extensiveness * Deliberation	0.00	1	0.00	0.00	0.97	0.00
Timeframe * Extensiveness * Deliberation	1.32		1.32	2.13	0.15	0.01
Originality						
Knowledge Test	5.19	1	5.19	10.62	0.00**	0.05
Divergent Thinking	3.74	1	3.74	7.66	0.01**	0.03
Timeframe	0.20	2	0.10	0.21	0.81	0.00
Extensiveness	0.36	1	0.36	0.74	0.39	0.00
Deliberation	0.07	1	0.07	0.14	0.71	0.00
Timeframe * Extensiveness	0.07	1	0.07	0.14	0.71	0.00
Timeframe * Deliberation	0.02	1	0.02	0.04	0.84	0.00
Extensiveness * Deliberation	0.16	1	0.16	0.33	0.56	0.00
Timeframe * Extensiveness * Deliberation	0.08	1	0.08	0.15	0.70	0.00
Elegance						
Knowledge Test	7.58	1	7.58	13.11	0.00**	0.06
Intelligence	5.95	1	5.95	10.29	0.00**	0.05
Timeframe	0.68	2	0.34	0.59	0.56	0.01
Extensiveness	0.36	1	0.36	0.62	0.43	0.00
Deliberation	0.02	1	0.02	0.03	0.85	0.00
Timeframe * Extensiveness	0.34	1	0.34	0.59	0.44	0.00
Timeframe * Deliberation	0.62	1	0.62	1.08	0.30	0.01
Extensiveness * Deliberation	0.02	1	0.02	0.03	0.85	0.00
Timeframe * Extensiveness * Deliberation	0.79	1	0.79	1.37	0.24	0.01

Note: ** indicates sig. at .01 level, * sig. at .05 level

Table 4.
ANCOVA Results for manipulations on rated scenario variable

Source	*SS*	*df*	*MS*	*F*	*Sig.*	η_p^2
Number of Errors Identified						
Knowledge Test	3.88	1	3.88	8.11	0.00**	0.04
Divergent Thinking	5.77	1	5.77	12.06	0.00**	0.05
Openness	2.21	1	2.21	4.62	0.03*	0.02
Timeframe	0.38	2	0.19	0.40	0.67	0.00
Extensiveness	1.31	1	1.31	2.74	0.10	0.01
Deliberation	0.11	1	0.11	0.22	0.64	0.00
Timeframe * Extensiveness	0.22	1	0.22	0.45	0.50	0.00
Timeframe * Deliberation	0.17	1	0.17	0.36	0.55	0.00
Extensiveness * Deliberation	0.55	1	0.55	1.15	0.29	0.01
Timeframe * Extensiveness * Deliberation	0.04	1	0.04	0.09	0.77	0.00
Number of Positive Outcomes						
Extra	0.17	1	0.17	3.06	0.08	0.02
Timeframe	0.03	1	0.03	0.48	0.49	0.00
Extensiveness	0.01	1	0.01	0.21	0.65	0.00
Deliberation	2.69	1	2.69	48.20	0.00**	0.20
Timeframe * Extensiveness	0.00	1	0.00	0.00	1.00	0.00
Timeframe * Deliberation	0.02	1	0.02	0.43	0.52	0.00
Extensiveness * Deliberation	1.19	1	1.19	21.37	0.00**	0.10
Timeframe * Extensiveness * Deliberation	0.13	1	0.13	2.26	0.13	0.01
Number of Negative Outcomes						
Divergent Thinking	4.03	1	4.03	12.20	0.00**	0.06
Timeframe	0.20	1	0.20	0.61	0.44	0.00
Extensiveness	3.06	1	3.06	9.29	0.00**	0.05
Deliberation	16.22	1	16.22	49.16	0.00**	0.20
Timeframe * Extensiveness	0.00	1	0.00	0.01	0.91	0.00
Timeframe * Deliberation	0.10	1	0.10	0.30	0.58	0.00
Extensiveness * Deliberation	0.26	1	0.26	0.80	0.37	0.00
Timeframe * Extensiveness * Deliberation	0.11	1	0.11	0.32	0.57	0.00
Specificity						
Knowledge Test	4.97	1	4.97	15.71	0.00**	0.08
Divergent Thinking	2.19	1	2.19	6.94	0.01**	0.04
Timeframe	1.53	1	1.53	4.84	0.03*	0.02
Extensiveness	1.28	1	1.28	4.04	0.05*	0.02
Deliberation	0.30	1	0.30	0.94	0.33	0.00
Timeframe * Extensiveness	0.36	1	0.36	1.15	0.28	0.01
Timeframe * Deliberation	0.50	1	0.50	1.58	0.21	0.01
Extensiveness * Deliberation	1.52	1	1.52	4.80	0.03*	0.02
Timeframe * Extensiveness * Deliberation	0.01	1	0.01	0.02	0.88	0.00

Note: ** indicates sig. at .01 level, * sig. at .05 level

Table 4.

Source	*SS*	*df*	*MS*	*F*	*Sig.*	η_p^2
Quality (Scenario)						
Knowledge Test	6.64	1	6.64	21.38	0.00**	0.10
Divergent Thinking	2.16	1	2.16	6.96	0.01**	0.04
Timeframe	1.18	1	1.18	3.80	0.05*	0.02
Extensiveness	1.44	1	1.44	4.63	0.03*	0.02
Deliberation	0.09	1	0.09	0.28	0.60	0.00
Timeframe * Extensiveness	0.22	1	0.22	0.70	0.40	0.00
Timeframe * Deliberation	0.47	1	0.47	1.50	0.22	0.01
Extensiveness * Deliberation	1.37	1	1.37	4.41	0.04*	0.02
Timeframe * Extensiveness * Deliberation	0.00	1	0.00	0.00	0.95	0.00

Note: ** indicates sig. at .01 level, * sig. at .05 level

Table 5.
ANCOVA results for rated scenario variables on quality, originality, and elegance

Source	*SS*	*df*	*MS*	*F*	*Sig.*	η_p^2
Quality						
Knowledge Test	2.43	1	2.43	4.12	0.04*	0.02
Intelligence	8.17	1	8.17	13.84	0.00**	0.07
Number of Errors ID	8.11	1	8.11	13.73	0.00**	0.07
Knowledge Test	4.79	1	4.79	7.77	0.01**	0.04
Intelligence	8.86	1	8.86	14.38	0.00**	0.07
Number of Positive Outcomes	3.10	1	3.10	5.04	0.03*	0.03
Knowledge Test	3.93	1	3.93	6.53	0.01**	0.03
Intelligence	7.44	1	7.44	12.34	0.00**	0.06
Number of Negative Outcomes	5.75	1	5.75	9.54	0.00**	0.05
Knowledge Test	3.27	1	3.27	5.66	0.02*	0.03
Intelligence	6.99	1	6.99	12.09	0.00**	0.06
Specificity	10.61	1	10.61	18.37	0.00**	0.09
Knowledge Test	2.38	1	2.38	4.20	0.04*	0.02
Intelligence	6.79	1	6.79	12.00	0.00**	0.06
Quality (Scenario)	12.90	1	12.90	22.78	0.00**	0.10
Originality						
Knowledge Test	3.20	1	3.20	6.82	0.01*	0.03
Divergent_Thinking	1.97	1	1.97	4.21	0.04**	0.02
Number of Errors ID	2.97	1	2.97	6.33	0.01*	0.03
Knowledge Test	4.59	1	4.59	9.71	0.00**	0.05
Intelligence	3.09	1	3.09	6.53	0.01**	0.03
Number of Positive Outcomes	2.11	1	2.11	4.46	0.04*	0.02
Knowledge Test	3.71	1	3.71	7.94	0.01**	0.04
Intelligence	2.96	1	2.96	6.33	0.01**	0.03
Number of Negative Outcomes	3.25	1	3.25	6.96	0.01**	0.03
Knowledge Test	3.58	1	3.58	7.70	0.01**	0.04
Intelligence	2.42	1	2.42	5.21	0.02*	0.03
Specificity	3.76	1	3.76	8.09	0.00**	0.04
Knowledge Test	2.63	1	2.63	5.85	0.02*	0.03
Intelligence	2.17	1	2.17	4.82	0.03*	0.02
Quality (Scenario)	6.72	1	6.72	14.95	0.00**	0.07

Note: ** indicates sig. at .01 level, * sig. at .05 level

Table 5.

Source	*SS*	*df*	*MS*	*F*	*Sig.*	η_p^2
Elegance						
Knowledge Test	2.89	1	2.89	5.24	0.02*	0.03
Divergent_Thinking	5.75	1	5.75	10.42	0.00**	0.05
Number of Errors ID	6.72	1	6.72	12.18	0.00**	0.06
Knowledge Test	5.17	1	5.17	9.06	0.00**	0.04
Intelligence	6.26	1	6.26	10.97	0.00**	0.05
Number of Positive Outcomes	3.11	1	3.11	5.45	0.02*	0.03
Knowledge Test	4.26	1	4.26	7.66	0.01**	0.04
Intelligence	5.07	1	5.07	9.11	0.00**	0.04
Number of Negative Outcomes	5.96	1	5.96	10.72	0.00**	0.05
Knowledge Test	3.83	1	3.83	7.01	0.01**	0.03
Intelligence	4.94	1	4.94	9.03	0.00**	0.04
Specificity	7.76	1	7.76	14.19	0.00**	0.07
Knowledge Test	2.78	1	2.78	5.26	0.02*	0.03
Intelligence	4.65	1	4.65	8.81	0.00**	0.04
Quality (Scenario)	11.46	1	11.46	21.71	0.00**	0.10

Note: ** indicates sig. at .01 level, * sig. at .05 level

Marketing Research

Customer Profile: Our average customer at Charamousse Clothing is an upwardly mobile extrovert with a passion for environmentalism. Our average customer spends a larger percentage of their budget on clothing than the average American consumer.

Age: The primary purchasers are between the ages of 25-39.

Brand Recognition/Power: we tend to be well known in the Midwest but in the South our name is relatively unknown.

Competitors: Our primary competitors tend to be designer clothing.

Education: Students have historically shown a strong interest in our products but our primary purchasers are typically college graduates. This finding could be due to the high price of our merchandise.

Gender: Charamousse clothing tends to be popular with both male and females, though historically 63% of our customers that ultimately purchase an article of clothing are female.

Income: The average income of the Charamousse customer hovers in the mid 60,000s. This income is notably higher than the national mean and shows that we tend to cater to more affluent clientele.

Interests and Activities: Our customers are much more likely than the general population to exercise regularly, typically through yoga or some other scheduled class rather than weight training or sports. They generally appreciate nature but spend little time outside. Lastly, the average customer tends to volunteer more than most Americans.

Location: To date we have been centered around Chicago so we cannot speak very much to a geographic location but we can say that our products tend to be in more metropolitan areas.

Similar Companies: Customers who buy Charamousse Clothing tend to also purchase products computers made by Apple, hybrid cars of any brand, and drinks made by Odwalla.

Figure 1. Charamousse market research summary

Overview of Errors

Definition: Errors are defined as mistakes in a solution, or missing information during the process of developing a solution.

Scenario: Your manager wants to celebrate the quarter by putting on a special event.
Potential idea: Make a brand new product to sell at the event.
Potential error: Not considering the cost of production for a product sold at one event.

Figure 2. Overview of errors

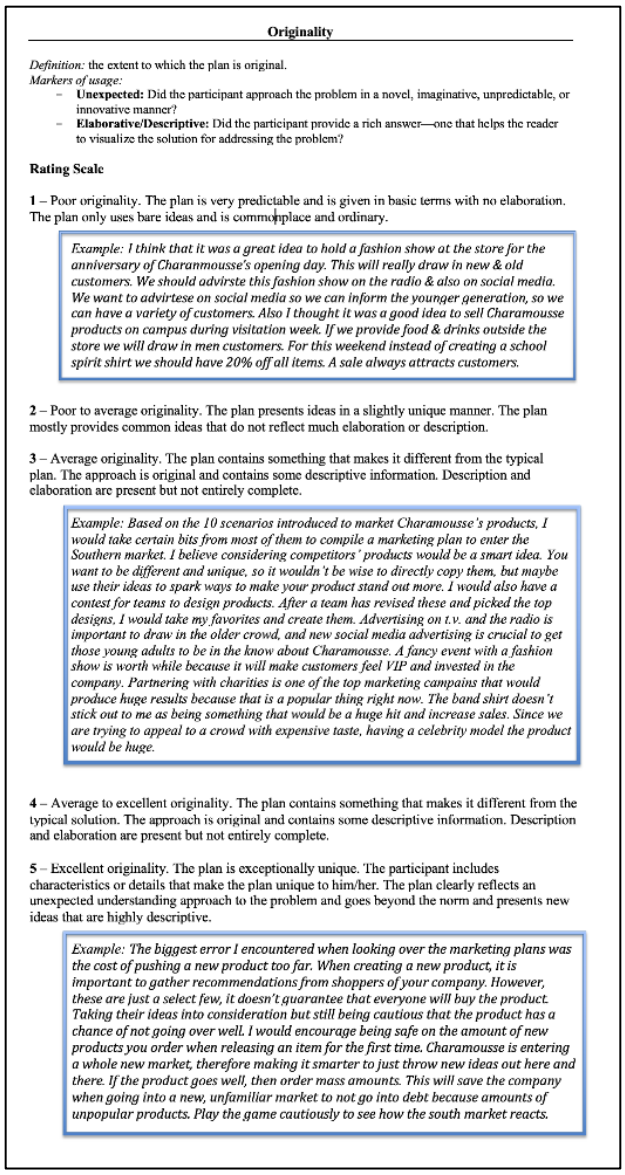
Scenario with errors:
A major clothing competitor is developing a new product that will directly compete with Charamouse's best selling product. Their product is unusually appealing and cheaper than Charamouse's product. In developing a new marketing plan, here are some ideas reported to your senior manager:

- A manager will observe differences in the competitor's product and implement them into Charamouse's product **Overlooking important alternatives**
- They will hold a directed group meeting for implementing these differences into the current design **Missing important causes**
- Have new product ready for release within 2-3 months **Unrealistic expectations of success**

Scenario without errors:
Your senior manager is holding a contest to see which team creates the best new product. Each team must have these products designed by the holiday season. You want to assemble your team and get a head start on this product. In developing a new marketing plan, here are some ideas reported to your senior manager:

- Obtain quantitative data on consumer interests.
- Assemble project team for idea generation and sharing.
- Come up with reasonable timeline for product development and assign tasks to group members.

Figure 3. Example scenarios with and without errors



Originality

Definition: the extent to which the plan is original.
Markers of usage:

- **Unexpected:** Did the participant approach the problem in a novel, imaginative, unpredictable, or innovative manner?
- **Elaborative/Descriptive:** Did the participant provide a rich answer—one that helps the reader to visualize the solution for addressing the problem?

Rating Scale

1 – Poor originality. The plan is very predictable and is given in basic terms with no elaboration. The plan only uses bare ideas and is commonplace and ordinary.

Example: I think that it was a great idea to hold a fashion show at the store for the anniversary of Charanmousse's opening day. This will really draw in new & old customers. We should advirste this fashion show on the radio & also on social media. We want to advirtese on social media so we can inform the younger generation, so we can have a variety of customers. Also I thought it was a good idea to sell Charamousse products on campus during visitation week. If we provide food & drinks outside the store we will draw in men customers. For this weekend instead of creating a school spirit shirt we should have 20% off all items. A sale always attracts customers.

2 – Poor to average originality. The plan presents ideas in a slightly unique manner. The plan mostly provides common ideas that do not reflect much elaboration or description.

3 – Average originality. The plan contains something that makes it different from the typical plan. The approach is original and contains some descriptive information. Description and elaboration are present but not entirely complete.

Example: Based on the 10 scenarios introduced to market Charamousse's products, I would take certain bits from most of them to compile a marketing plan to enter the Southern market. I believe considering competitors' products would be a smart idea. You want to be different and unique, so it wouldn't be wise to directly copy them, but maybe use their ideas to spark ways to make your product stand out more. I would also have a contest for teams to design products. After a team has revised these and picked the top designs, I would take my favorites and create them. Advertising on t.v. and the radio is important to draw in the older crowd, and new social media advertising is crucial to get those young adults to be in the know about Charamousse. A fancy event with a fashion show is worth while because it will make customers feel VIP and invested in the company. Partnering with charities is one of the top marketing campains that would produce huge results because that is a popular thing right now. The band shirt doesn't stick out to me as being something that would be a huge hit and increase sales. Since we are trying to appeal to a crowd with expensive taste, having a celebrity model the product would be huge.

4 – Average to excellent originality. The plan contains something that makes it different from the typical solution. The approach is original and contains some descriptive information. Description and elaboration are present but not entirely complete.

5 – Excellent originality. The plan is exceptionally unique. The participant includes characteristics or details that make the plan unique to him/her. The plan clearly reflects an unexpected understanding approach to the problem and goes beyond the norm and presents new ideas that are highly descriptive.

Example: The biggest error I encountered when looking over the marketing plans was the cost of pushing a new product too far. When creating a new product, it is important to gather recommendations from shoppers of your company. However, these are just a select few, it doesn't guarantee that everyone will buy the product. Taking their ideas into consideration but still being cautious that the product has a chance of not going over well. I would encourage being safe on the amount of new products you order when releasing an item for the first time. Charamousse is entering a whole new market, therefore making it smarter to just throw new ideas out here and there. If the product goes well, then order mass amounts. This will save the company when going into a new, unfamiliar market to not go into debt because amounts of unpopular products. Play the game cautiously to see how the south market reacts.

Figure 4. Example benchmark rating scale