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FORECASTING AND EARLY CYCLE CREATIVE PROCESSES: EFFECTS ON COMPLEX PROBLEM SOLVING

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FORECASTING AND EARLY CYCLE CREATIVE PROCESSES: EFFECTS ON COMPLEX PROBLEM SOLVING

A DISSERTATION APPROVED FOR THE

DEPARTMENT OF PSYCHOLOGY

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Abstract

Prior research has identified a core set of early and late processes that make up creative problem-solving. Additionally, researchers have highlighted certain skills that further bolster creative output. The importance of one such skill, forecasting, has been observed many times in prior studies. However, these studies tend to observe forecasting in late stages of creativity. Little is known about how forecasting functions if it is carried out earlier in the creative problem-solving process. Along similar lines relatively little is known about how positive and negative valence of forecasts function when carried out early in the process of creative cognition. In the present study, 267 undergraduates were asked to take on the role of a restaurant development consultant and to develop a plan for a new restaurant concept. Participants responded to prompts which primed each stage of the creative problem-solving process before coming up with a final plan for a new restaurant. Manipulations were embedded into the prompts to alter valence and timeframe of their forecasts. It was found that thinking in terms of long-term or both long-term and short-term consequences is beneficial to creative problem solving. Additionally, a positive valence of forecasts was seen to be beneficial to certain creative processes, however for a higher quality, more original, and more elegant final product, a negative valence was seen to be critical. The implications of these findings for understanding forecasting and creative problem solving are discussed.

Introduction

The global market of this century has underscored the necessity of innovative products and services. Given rapid technological advances, increased competition, and globalization of products and services, it can be said that there is a premium on innovation (Dess & Pickens, 2000; Mumford & Hunter, 2005). More importantly, it's seen that innovation is a key factor in an organization's ability to create a sustainable competitive advantage (Kim et al.,1999). Companies such as General Motors and Walmart, firms not traditionally concerned with innovation within their respective domains, have placed an emphasis on, and found success in innovative outputs (Mumford et al., 2017).

Innovation, as defined by Mumford and Gustafson (1988), is the implementation of creative solutions. Thus, the precursor to innovation for firms is the creativity of solutions generated by its employees (Amabile, 1996; Denti & Hemlin, 2012; Eisenbeiss et al., 2008). There are different definitions for creativity in the existing literature, but the most widely accepted definition of creativity states that it involves the production of high quality, original, and elegant solutions to a novel, complex, and ill-defined problem (Besemer & O'Quinn, 1999; Mumford & Gustafson, 1988, 2007). The root of innovation, then, is the effectiveness with which problems requiring creativity are solved.

Creative Problem Solving

Given the novel, complex, and ill-defined nature of creative problems, it is important to understand how people work through problems requiring creativity. Scholars interested in creative problem solving have conceptualized the creative problem-solving process in different ways (Reiter-Palmon & Illies, 2004), including at the individual (e.g., Amabile, 1996; Mumford & Gustafson, 1988, Treffinger & Isaksen, 1992) and organizational (e.g., Woodman et al., 1993;

Ford, 1996) level. In their review of the various models of creative problem solving, Mumford and colleagues (1991) identified a core set of processes seen as central to creativity. Their analysis resulted in an eight-stage model which included (a) problem identification, (b) information gathering, (c) conceptual selection, (d) conceptual combination, (e) idea generation, (f) idea evaluation, (g) implementation planning, and (h) monitoring. An additional aspect of this model is that it is not necessarily linear, but cyclical, in nature. In other words, output of later stages within the model are dependent on successful execution of earlier processes. If a satisfactory outcome cannot be obtained in one stage, individuals can cycle back to an earlier stage to address deficiencies. Thus, there is serial dependency between the eight stages. See Figure 1 for a depiction of Mumford et al.'s (1991) model.

Insert Figure 1 About Here

In a more global sense, the model put forth by Mumford et al. (1991) proposes that the basis of creative problem solving is information and knowledge, which is combined, reorganized, evaluated, and shaped into the form of a plan or solution for a novel, complex, and ill-defined problem (Mumford et al., 2012). The final stages of this model involve the problem solver to think about how the solution will play out in the context of their work environment. Envisioning the plan within a particular context inherently involves planning (Mumford et al., 1991). Moreover, forecasting, which is one aspect of planning, has been shown to be especially crucial to successful implementation a solution (Osburn & Mumford, 2006).

Forecasting and Creative Problem Solving

Forecasting is the projection of future outcomes of a particular action or set of actions (Mumford et al., 2002; Mumford et al., 2001). Forecasting, at a deeper level, is dynamic and involves environmental monitoring, such that forecasted outcomes can be revised as different events unfold (Mumford, Steele et al., 2015). Mumford, Steele and colleagues (2015) also saw that forecasting allowed for a greater range of situations to be envisioned, enabling identification of a broader set of causes impacting the success or failure of a particular outcome. Thus, effective forecasting increases the identification of contingencies and obstacles in the environment, preventing potential problems before they occur, and providing alternatives to issues should they come up.

The importance of forecasting's impact on creative problem solving has been demonstrated in two prior studies by Byrne et al. (2010) and Shipman et al. (2010). In both studies, participants were asked to assume the role of a leader and formulate a vision for leading their organization. While working on the vision formation task, participants were presented with a series of emails in which they were asked to forecast the implications of their ideas. The forecasts produced by participants were subsequently rated by a panel of trained judges.

In the Byrne et al. (2010) study, 27 forecasting attributes were rated by trained judges and three forecasting factors emerged: forecasting extensiveness, forecasting negative outcomes, and forecasting constraints. In the Shipman et al. (2010) study, a factoring of 21 rated forecasting attributes resulted in four forecasting dimensions: forecasting resources, forecasting extensiveness, forecasting time frame, and forecasting negative outcomes. In both studies, forecasting was found to be strongly, positively related to quality, originality, and elegance of solutions to marketing problems. Two factors, forecasting extensiveness and time frame, were found to have correlations in the 0.20s to 0.40s with the quality, originality, and elegance of problem solutions (Shipman et al., 2010). Additional studies (e.g., Marta et al., 2005; Osburn & Mumford, 2006) have demonstrated that the quality and extensiveness of forecasting is positively related to creative problem-solving performance.

Based on these handful of studies, there is a notable influence of forecasting on creative problem solving, however the studies showing these effects have been carried out in a limited number of contexts (i.e., experimental task). Thus, further study of the influence of forecasting on creative problem solving is warranted. More specifically, the replication of previous findings on a varied creative problem-solving task is of value.

Hypothesis 1: Forecasting extensiveness will improve creative performance.

Hypothesis 2: Forecasting quality will improve creative performance.

Forecasting Approaches

Forecasting Timing

Returning to Mumford et al.'s (1991) eight stage model of creativity, an important point should be noted with respect to forecasting. That is, the model can be broken up into the early and late stages of creative problem solving (Mumford, 2003; Mumford et al., 1991). The early stage consists of problem definition, information gathering, conceptual selection, and conceptual combination. The late stage consists of idea generation, idea evaluation, implementation planning, and solution monitoring.

As seen in the extant literature, forecasting is typically thought to take place during idea evaluation, a late-stage process. Attribution of forecasting to late-stage processes resulted from creativity researchers drawing from the planning literature (Mumford et al., 2001; Mumford, Mecca et al., 2015; Mumford, Steele et al., 2015). However, there may be some merit to forecasting earlier in the creative process.

Forecasting is a cognitively demanding task (Mumford, Steele et al., 2015) and it is possible that the timing with which forecasting occurs during the creative process may reduce demands, thereby improving creative performance (McIntosh et al., 2021). Earlier, it was mentioned that the eight-stage model of creativity proposed by Mumford and his colleagues in 1991, has serial dependency. In other words, the outcome of one stage is dependent on successful execution earlier stages. Thus, if a satisfactory outcome cannot be obtained for a particular stage, individuals can cycle back to an earlier stage to remedy deficiencies. If forecasting, a resource intensive task, is to take place in later stages and a satisfactory outcome cannot be achieved, one must cycle back to earlier stages, remedy deficiencies, and return to later stages to forecast once again. This "back and forth" would utilize a great deal of cognitive resources.

Additionally, given that effective forecasting increases the identification of problem attributes such as causes and constraints (Mumford et al., 2002; Mumford, Steele et al., 2015), if one were to forecast early in the creative problem-solving process (i.e., during problem identification), they may be able to better identify problem attributes early on, benefiting subsequent early-stage activities such as information gathering, conceptual selection and conceptual combination. Carrying out early-stage processes more effectively may, in turn, improve effectiveness of late-stage activities and require less cycling back.

There is very little research examining the impact of timing of forecasting on creative performance. In reviewing the literature one study, by McIntosh et al. (2021), address this gap. In this study undergraduate participants were asked to develop a new restaurant concept. After reading some background material, they were asked to generate a list of restaurant ideas, evaluate those ideas, and then come up with a final restaurant plan. Participants forecasted either during idea generation or after they had generated all their ideas. It was seen that those who forecasted during idea generation (i.e., earlier in the process) had greater quality, range, and depth of idea evaluations (Mcintosh et al., 2021). Put differently, those who forecasted earlier in the creative process carried out the next stage of the model more effectively. This finding provides some evidence for the claim that forecasting early benefits subsequent stages; however, this study examined the impact of forecasting early on idea generation and idea evaluation which are "late stages" of the eight-stage model. Thus, there is no research examining the impact of forecasting during "early stages" on subsequent stages and creative performance. Hence the research questions:

Research Question 1: How will forecasting during problem identification impact subsequent early-stage processes?

Research Question 2: How will forecasting during problem identification impact subsequent late-stage processes?

Research Question 3: How will forecasting during problem identification impact overall creative performance?

Forecasting Valence

Forecasting has been shown to be a powerful influence on creative performance, but little is understood about the valence of forecasting. As seen in previous studies, effective forecasting itself, will generally result in better performance (Byrne et al., 2010; Shipman et al., 2010). However, relatively little empirical and theoretical work suggests the extent to which forecasts should be positive or negative in nature. McIntosh et al. (2021) found that participants who forecasted both positive and negative outcomes had more effective forecasting, as evidenced by higher ratings of forecasting extensiveness and quality. Additionally, those who forecasted both positive and negative events also had more elegant creative outputs. Mulhearn et al. (2020), on the other hand, found that valence of forecasts did not impact creative performance. These set of findings provide conflicting views on the relationship between valence and forecasting. Given forecasting's relationship to creativity, drawing from the creativity literature may offer some insight. Specifically, research on the influence of affect on creativity could provide some answers.

There is somewhat of a debate in the creativity domain regarding the impact of affect on creativity (Anderson et al., 2014; James et al., 2009). A large part of the literature (e.g., Estrada et al., 1994, 1997; Isen, 1999; Isen et al., 1987) states that positive affect enhances creativity. However, some researchers (e.g., George & Zhou, 2002; Kaufman & Vosburg, 1997) state that negative affect enhances creativity. In a review of the literature, Baas et al. (2008) found that positive affect was related to better performance on divergent thinking tasks such as the Remote Association Test and Duncker's (1945) candle problem, whereas negative affect promoted performance on tasks that required a more systematic and detailed information processing style. It is important to note that divergent thinking is related to idea generation such that greater divergent thought results in the generation of a larger number of ideas (Guilford, 1966; Mumford et al., 1998; Runco, 1991). So, positive affect may benefit idea generation, while negative affect, may benefit systematic implementation of an idea. It is critical to note here that affect and valence are not one and the same with respect to their relationship to creative problem solving. Although they are not the same, Bass et al.'s (2008) findings on affect could also apply to a similar connection between valence and creative problem solving. Affect impacts how one approaches a problem, in a similar way forecasting valence also influences how one frames a situation and their subsequent considerations. Additionally, Bass and colleagues' (2008) findings are in line with findings of Antes and Mumford (2012), who suggests that a balance of positive and negative framing strategies results in the most effective problem solving for leaders.

The findings of Baas et al. (2008) and Antes and Mumford (2012) provide some insight into how forecasting valence may impact creative performance. It may be the case that positive and negative forecasts are differentially impacting creativity at various stages of the creative problem-solving process. McIntosh et al. (2021) and Mulhearn et al. (2020) examined the impact of forecasting valence on other forecasting attributes (i.e., extensiveness and quality) as well as on the final output, but did not examine how forecasting valence may impact other stages of creative problem solving. This observation yields the research question:

Research Question 4: What is the impact of forecasting valence on early-stage creative processes?

Research Question 5: What is the impact of forecasting valence on late-stage creative processes?

The purpose of the present effort is threefold: First, replicate the findings of previous studies regarding the impact that forecasting extensiveness and quality have on creative performance. Second to act as an exploratory study with regards to the impact of forecasting in the early stages on subsequent creative processes. Third, to act as an exploratory study with regards to the impact of positive and negatively valanced forecasts on early- and late-stage creative processes.

Method

Sample

The sample used to test the hypotheses and research questions consisted of 267 undergraduate students attending a large southwestern university. The 89 males and 178 females were recruited from who agreed to participate in this study were recruited from undergraduate psychology courses providing credit for participation in experimental studies. Those seeking credit were asked to review a departmental website where a short, one paragraph, description of the available studies was provided. They then selected the study, or studies, in which they wanted to participate. The average age of those who agreed to participate in the present investigation was 19 years old. The average ACT score was 25.5, roughly a standard deviation above the mean, while the average overall GPA was 3.6.

General Procedures

Students were recruited to participate in a study of creative problem solving in an organizational setting. This study would be completed online, using a survey designed using Qualtrics. Upon clicking on the survey link, students were randomly assigned into one of 9 experimental conditions (3x3 design) and directed to the survey corresponding to that condition. After reading the consent form and electronically providing consent, the participants completed a set of timed covariate measures. These timed covariate measures examined relevant cognitive abilities. Following the timed covariate measures the participants moved on to the experimental task which involved developing a proposal for a new restaurant. Then, participants provided demographic information and were asked to complete a set of untimed covariate control measures. Finally, participants were debriefed.

Covariates

Based on the observations of Antonakis et al. (2020) the first covariate measure participants were asked to complete was a measure of verbal intelligence. This verbal intelligence measure was drawn from the Employee Aptitude Survey (EAS). The 30 items included in the EAS verbal reasoning measure present a set of facts bearing on a problem. People are asked to indicate whether a subsequent answer is true, false, or unknown given these facts. This verbal reasoning measure yields retest reliabilities above 0.80. Evidence bearing on the predictive and construct validity of this measure has been provided by Grimsley et al. (1985) and Ruch and Ruch (1983).

Merrifield et al.'s (1962) consequences test was used to assess creative capacity. In this timed measure of divergent thinking, participants were presented with five unique scenarios, such as "what would happen if people lost the ability to read and write?" or "what would happen if gravity were cut in half?". For each scenario, participants were asked to list as many consequences as possible in two minutes. Participant responses were coded for fluency and flexibility, where fluency was operationalized as the average number of consequences produced in response to each question and where flexibility was operationalized as the average number of categories of ideas. The measure yields an internal consistency coefficient of .70. Merrifield et al. (1962) and Mumford et al. (1998) have provided evidence for the construct and criterion-related validity of this measure.

Cacioppo et al.'s (1984) need for cognition scale was used to assess the extent to which participants were intrinsically motivated to solve complex problems. This scale consists of 18 statements (e.g., "I would prefer complex to simple problems") in which participants indicate their level of agreement on a five-point scale. The measure yields an internal consistency coefficient of .90. Evidence of the measure's construct validity has been provided by Cacioppo et al. (1996) and Watts et al. (2016).

Participants were also asked to complete an omnibus assessment of personality. Personality was assessed using Costa and McCrae's (1992) NEO-FFI scale. This 60-item measure assesses the Big Five personality characteristics (i.e., openness, conscientiousness, extraversion, agreeableness, and emotional stability). The internal consistency coefficients for each of the personality characteristics exceeded 0.70. Evidence for the construct validity of this measure has been provided by Scandell (2000) and McCrae and Costa (2004).

Given that the task at hand required planning, participants were asked to complete Marta et al.'s (2005) measure of planning skills. On this measure, people are presented with 15 case abstracts describing incidents of business leader planning. They are then asked to answer a series of five questions with eight to twelve potential responses. Participants are asked to select their two to four preferred options, where response options were structured to reflect key planning skills (e.g., forecasting, identification of restrictions, and identification of key causes). When scored for overall planning skill, this measure yields split half reliabilities above 0.80. Marta et al. (2005) have provided evidence for the predictive validity of this measure in accounting for planning performance.

Because task-relevant expertise is essential to creative performance (Hershey et al. 1990), expertise was measured using a background data measure intended to assess restaurant expertise (Gibson & Mumford, 2013; Medeiros et al., 2018). Modified from Gibson & Mumford (2013) to fit the restaurant domain, participants responded to six questions using a five-item response scale. Examples of questions asked include, "How confident are you that you know the issues and concepts used by restaurant owners and operators?" and "How likely is it that you will go into the restaurant industry as a career?". The resulting scale yields internal consistency coefficients of .69. Evidence for the construct validity of this scale as a measure of restaurant expertise has been provided by Medeiros et al. (2018).

Experimental Task

The experimental utilized in this effort was the O'Toole restaurant development task, and was adapted from Medeiros et al., (2018). In this task, participants were asked to take on the role of a newly hired Product Development Manager working in the Research and Development arm of a Restaurant Development Firm, O'Toole Restaurant Consultants, Inc. Participants were tasked with developing a new restaurant concept that the firm would develop and manage. Participants began the task by reading through relevant background information regarding their role, the company, and the current market (e.g., customer experience, cuisine trends, and service approaches). After reviewing this information, participants received a series of 8 "emails" from their supervisor, asking them to complete certain tasks. Participants would complete one task before clicking next to move onto the following task. Each of these "emails" was tied to a specific stage of the creative problem-solving process and their intent was to get the participant to execute each particular stage. For example, the first "email" was tied to problem identification and asked the participant to "Identify the key challenges for this project". The second "email" was tied to information gathering and asked the participant to "List the information which is the most important to pay attention to". The manipulations were both embedded in the task for the first "email" which prompted problem identification. This was done in order to promote forecasting early so that the impact of forecasting early on subsequent stages could be examined. The first manipulation told the participants to focus on long-term, short-term, or long-term *and* short-term consequences in their forecasts. The second manipulation told the participants to think of positive outcomes, negative outcomes, or positive *and* negative outcomes.

Experimental Task Prompts

Prompts were adapted from Medeiros et al., (2018).

Problem ID. "Remember, you have been asked to list and describe the key challenges for this project…"

Information Gathering. "Remember, you have been asked to list key information you think should be attended to as we move forward. In other words, let us know what information is the most important to pay attention to."

Concept selection. "Remember, you have been asked to consider major causes, constraints, user groups, and other factors that would be crucial to pay attention to while creating a new, successful restaurant."

Conceptual Combination. "Remember, you have been asked to incorporate ALL of the executives' ideas into a proposal."

Idea Generation. "Remember, you have been asked to come up with your own ideas."

Idea Evaluation. "Remember, you have been asked to evaluate your best 3 ideas."

Manipulations

Forecasting Timeframe. The timeframe of forecasts was manipulated by presenting participants with an "email" asking them to "Identify and describe the key challenges for this project" while focusing on either long-term, short-term, or long-term *and* short-term consequences if these issues or challenges are unaddressed. A text box was provided in the survey for participants to type out the key challenges as well as forecasted outcomes.

Forecasting Valence. The valence of forecasts was manipulated by presenting participants with an "email" asking them to "Identify and describe the key challenges for this project" while focusing on either positive outcomes, negative outcomes, or positive *and* negative outcomes if these issues or challenges are unaddressed. A text box was provided in the survey for participants to type out the key challenges as well as outcomes.

Dependent Variables

Three trained judges, blind to the study's experimental conditions and research objectives, coded participants' problem identification, forecasts, information gathering, conceptual selection, conceptual combination, idea generation, idea evaluation, and final plan. Problem identification was rated for 1) number of constraints and 2) quality. Forecasts were rated for 1) short-term timeframe, 2) long-term timeframe, 3) extensiveness, and 4) quality. Information gathering and conceptual selection were both rated for quality. Conceptual combination and idea generation were rated for 1) quality and 2) originality. Idea evaluation was rated for 1) depth and 2) usefulness. The final plans were rated for 1) quality, 2) originality, and 3) elegance. Benchmark rating scales have been shown to result in more reliable and valid ratings when trained judges are asked to appraise complex subject matter (Redmond, Mumford, & Teach, 1993). To develop benchmark rating scales for all variables, three judges, doctoral students familiar with the creativity literature, were asked to rate a set of twenty-five sample proposals on a five- point scale, using provided definitions for each variable. These ratings were used to identify restaurant proposals near the high, medium, and low scale points that evidenced cross-rater agreement. These restaurant proposals were abstracted and used to form scale anchors.

Three raters familiar with the creativity literature, were asked to apply these rating scales in evaluating the variables mentioned above as well as the final restaurant proposals. Prior to making these ratings, judges were required to complete a twenty-hour training program. In this training program, judges were familiarized with benchmark rating scales and operational definitions for all variables. Judges practiced applying these scales to sample participant responses and subsequently met to resolve any discrepancies and discuss their ratings. The dependent variables were rated on a five-point Likert scale, with 1 indicating minimal to no presence of the variable and 5 indicating a strong presence of the variable.

Problem Identification Number of Constraints

The number of constraints was a numerical count of the distinct issues/constraints identified. Interrater agreement estimate was acceptable at 0.80.

Problem Identification Quality

The extent to which the identified constraints displayed relevance to the scenario and the degree to which the participant provided a complete, coherent, and logical set of problem statements. Interrater agreement estimate was acceptable at 0.80.

Forecasting Short-Term

The degree to which the forecast focused on the short-term consequences. With short-term meaning consequences taking place within 6 months of implementation of an idea. Interrater agreement estimate was acceptable at 0.83.

Forecasting Long-Term

The degree to which the forecast focused on the long-term consequences. With long-term meaning consequences taking place after 6 months of implementation of an idea. Interrater agreement estimate was acceptable at 0.83.

Forecasting Extensiveness

The extent to which the forecasts considered a wide range of situations and outcomes. Interrater agreement estimate was acceptable at 0.82.

Forecasting Quality

The degree to which the forecasted outcomes displayed detail, relevance to the scenario, consider critical aspects of the scenario, and were realistic. Interrater agreement estimate was acceptable at 0.79.

Information Gathering Quality

The extent to which the information selected/mentioned by the participant displayed detail, was relevant to the scenario, considered critical aspects of the scenario, and was realistic. Interrater agreement estimate was acceptable at 0.86.

Conceptual Selection Quality

The degree to which selected concepts identified key causes, constraints, and user groups. Interrater agreement estimate was acceptable at 0.88.

Conceptual Combination Quality

The extent to which idea(s) presented was complete, logical, and useful. The ideas addressed key concepts/issues identified earlier and were presented in a coherent and useful manner. Interrater agreement estimate was acceptable at 0.84.

Conceptual Combination Originality

The extent to which the concepts were combined into an idea or set of ideas which were novel, unique, or surprising. The interrater agreement estimate was acceptable at 0.78.

Idea Generation Quality

The extent to which generated ideas were complete, presented in a coherent manner and were useful. The interrater agreement estimate was acceptable at 0.82.

Idea Generation Originality

The degree to which the generated ideas were novel, unique, or surprising. The interrater agreement estimate was acceptable at 0.76.

Idea Evaluation Depth

The extent to which evaluations were thorough, insightful, and thoughtful. The interrater agreement estimate was acceptable at 0.87.

Idea Evaluation Usefulness

The degree to which critiques could be addressed in a practical manner. The interrater agreement estimate was acceptable at 0.78.

Final Plan Quality

Quality was defined as the extent to which the participant's restaurant proposal was comprehensive, coherent, and feasible**.** The interrater agreement estimate was acceptable at 0.85.

Final Plan Originality

Originality was defined as the extent to which the participant's final restaurant proposal was novel, unexpected, and clever. The interrater agreement estimate was acceptable at 0.80.

Final Plan Elegance

Elegance was defined as the extent to which the participant's final restaurant proposal was articulately arranged in a succinct, flowing fashion (Dailey & Mumford, 2006; Scott, Lonergan, & Mumford, 2005). The interrater agreement estimate was acceptable at 0.84.

Analyses

Analyses of covariance (ANCOVA) tests were conducted to assess the impact of the manipulations on dependent variables. Covariates were retained only at the 0.005 significance level. Main effects and interactions were considered statistically significant if they evidenced a p-value $\leq .05$.

Results

Correlations

Table one presents the descriptive statistics and correlations among the significant covariates and dependent variables. As may be seen, forecasting extensiveness was found to be significantly correlated with final plan quality, originality and elegance with correlations ranging from 0.29 to 0.31. Forecasting quality was also found to be significantly correlated with final plan quality, originality and elegance with correlations ranging from 0.23 to 0.29. These findings support prior research suggesting that characteristics of forecasting such as extensiveness and quality, benefit creative performance (Shipman et al., 2010) and provide support for the first and second hypotheses.

Insert Table 1 About Here

Problem Identification

Table two presents the ANCOVA results obtained for number of constraints identified in problem identification. Planning skill ($F(1,257) = 10.21$, $p < 0.05$) was a significant covariate, proving to be positively related to number of constraints identified. A significant ($F(2,257) = 13.86$, $p < 0.001$) main effect for valence was obtained. Inspection of cell means indicated that those who forecasted positive outcomes identified more constraints ($M = 2.46$, $SE = 0.07$) than participants who forecasted only negative outcomes ($M = 2.24$, $SE = 0.06$) or both positive and negative outcomes ($M = 1.96$, $SE = 0.07$). There was also a significant ($F(4,257) = 5.45$, $p < 0.001$) two-way interaction between timeframe and valence. Inspection of the cell means indicated that those who forecasted both short-and long-term outcomes with a positive valence identified the most constraints.

Insert Table 2 About Here

Table three presents the ANCOVA results obtained for quality of problem identification. Planning skill (F (1,257) = 18.29, $p < 0.01$) was a significant covariate, proving to be positively related to quality of problem identification. No significant main effects emerged, but there was a significant (F (4,257) = 5.25, $p < 0.001$) two-way interaction between timeframe and valence. Inspection of the cell means indicated that those who forecasted only short-term outcomes with a only a positive valence had the highest quality problem identification (M = 2.52, SE = 0.12).

Insert Table 3 About Here

Forecasting

Table four presents the ANCOVA results for short-term forecasts. Planning skill (F (1,257) = 9.45, $p < 0.05$) was a significant covariate, proving to be positively related to identification of short-term consequences. A significant (F (2,257) = 14.07, $p < 0.001$) main effect for valence was obtained. Inspection of cell means indicated that those who forecasted only positive outcomes identified more short-term consequences (M = 1.92, SE = 0.04) than participants who forecasted only negative outcomes (M = 1.62, SE = 0.04) or both positive and negative outcomes (M = 1.85, SE = 0.04).

Insert Table 4 About Here

Table five presents the ANCOVA results for long-term forecasts. Unsurprisingly, planning skill (F (1,257) = 9.24, $p < 0.05$) was a significant covariate, proving to be positively related to identification of long-term consequences. A significant (F (2,257) = 3.34, $p < 0.05$) main effect for valence was obtained. Inspection of cell means indicated that those who forecasted only positive outcomes identified more long-term consequences (M = 2.14, SE = 0.06) than participants who forecasted only negative outcomes (M = 1.92, SE = 0.06) or both positive and negative outcomes (M = 1.98, SE = 0.06). A significant two-way interaction (F (4,257) = 3.84, $p < 0.05$) between timeframe and valence was seen. Inspection of the cell means indicated that those in the only long-term forecasting condition who also forecasted only positive outcomes identified more long-term consequences (M = 2.27, SE = 0.11) than any other group.

Insert Table 5 About Here

Table six presents the ANCOVA results for forecasts extensiveness. Again, planning skill (F (1,257) = 10.01, $p < 0.05$) was a significant covariate, proving to be positively related to extensiveness of forecasts. No significant main effects were seen, but a significant two-way interaction between timeframe and valence was observed (F (4,257) = 4.89, $p < 0.001$). Cell means indicated that those who forecasted both short- and long-term consequences with only a negative valence had the most extensive forecasts (M = 2.18, SE = 0.11) compared to any other group.

Insert Table 6 About Here

Table seven presents the ANCOVA results for forecast quality. Yet again, planning skill (F (1,257) = 16.11, $p < 0.001$) was a significant covariate, proving to be positively related to quality of forecasts. A significant (F (2,257) = 5.66, $p < 0.05$) main effect for valence was obtained. Inspection of cell means indicated that those who forecasted only positive outcomes had higher quality forecasts (M = 2.12, SE = 0.06) than participants who forecasted only negative outcomes (M = 1.85, SE = 0.06) or both positive and negative outcomes (M = 2.04, SE = 0.06).

Insert Table 7 About Here

Information Gathering

Table eight presents the ANCOVA results for information gathering quality. Divergent thinking (F (1,257) = 10.51, $p < 0.05$) and agreeableness (F (1,257) = 6.59, $p < 0.05$) were significant covariates, indicating that they are both positively related to quality of information gathered. A significant (F (2,257) = 3.56, $p < 0.05$) main effect for timeframe was obtained. Cell means indicated that those who forecasted only long-term consequences had higher quality information gathering (M = 2.26, SE = 0.05) than participants who forecasted only short-term consequences (M = 2.06, SE = 0.05) or both long- and short-term consequences (M = 2.18, SE = 0.05). A significant two-way interaction (F (4,257) = 5.19, $p < 0.001$) between timeframe and valence was seen. Inspection of the cell means indicated that those who forecasted both long-term and short-term consequences with both a positive and negative valence had the highest quality of information gathering (M = 2.42, SE = 0.09) compared to any other group.

Insert Table 8 About Here

Conceptual Selection

Table nine presents the ANCOVA results for conceptual selection quality. Divergent thinking (*F* (1,257) = 8.38, $p < 0.05$) and openness (*F* (1,257) = 7.20, $p < 0.05$) were significant covariates, indicating that they are both positively related to quality of concept selection. A significant main effect for timeframe was observed (*F* (2,257) = 11.42, $p < 0.001$). Cell means indicated that those who forecasted only long-term consequences had higher quality concept selection (*M* = 2.14, *SE* = 0.05) than participants who forecasted only short-term consequences (*M* = 1.89, *SE* = 0.05) or both long- and short-term consequences (*M* = 1.85, *SE* = 0.05). A significant main effect of valence was also seen (*F* (2,257) = 4.73, $p < 0.05$). Cell means indicate that those who forecasted both positive and negative outcomes had higher quality of concept selection (*M* = 2.10, *SE* = 0.05) than participants who forecasted only negative outcomes (*M* = 1.85, *SE* = 0.05) or only positive outcomes (*M* = 1.96, *SE* = 0.05).

A significant two-way interaction was also observed between timeframe and valence (*F* (4,257) = 5.81, $p < 0.001$). Inspection of cell means indicate that those who forecasted only long-term consequences with only a negative valence had the highest quality of concept selection (*M* = 2.22, *SE* = 0.07) compared to any other group.

Insert Table 9 About Here

Conceptual Combination

Table ten present ANCOVA results for conceptual combination quality. Yet again, planning skill (*F* (1,257) = 10.22, $p < 0.05$) was a significant covariate, proving to be positively related to quality of conceptual combination. No significant main effects were observed. However, a significant two-way interaction between timeframe and valence was seen (F (4,257) = 4.81, $p < 0.001$). Cell means show that those who forecasted only short-term consequences with only a positive valence had the highest quality conceptual combination (M = 2.74, SE = 0.09).

Insert Table 10 About Here

Table eleven presents the ANCOVA results for conceptual combination originality. Planning skill (F (1,257) = 8.79, $p < 0.05$) was a significant covariate, proving to be positively related to originality of conceptual combination. A significant main effect of timeframe was seen (F (2,257) = 5.22, $p < 0.05$). Cell means indicated that those who forecasted only short-term consequences had more original conceptual combination (M = 2.32, SE = 0.06) than participants who forecasted only long-term consequences (M = 2.08, SE = 0.06) or both long- and short-term consequences (M = 2.31, SE = 0.06). A significant two-way interaction was also observed between timeframe and valence (F (4,257) = 8.18, $p < 0.001$). Cell means show that those who forecasted only long-term consequences with only a negative valence had the most original conceptual combination (M = 2.46, SE = 0.09) compared to any other group.

Insert Table 11 About Here

Idea Generation

Table twelve shows the ANCOVA results for idea generation quality. Planning skill (F (1,257) = 9.68, $p < 0.05$) was a significant covariate, proving to be positively related to quality of ideas generated. Only a significant main effect for timeframe was observed (F (2,257) = 4.03, $p < 0.05$). Cell means indicated that those who forecasted only long-term consequences generated higher quality ideas (M = 2.22, SE = 0.06) than participants who forecasted only short-term consequences (M = 2.06, SE = 0.06) or both long- and short-term consequences (M = 2.01, SE = 0.06).

Insert Table 12 About Here

Table thirteen presents the results of the ANCOVA for idea generation originality. No significant covariates were seen in this analysis. A significant main effect for timeframe was observed (F (2,257) = 5.62, $p < 0.05$). Cell means indicated that those who forecasted only long-term consequences generated more original ideas (M = 2.29, SE = 0.06) than participants who forecasted only short-term consequences (M = 2.01, SE = 0.06) or both long- and short-term consequences (M = 2.04, SE = 0.06). Additionally, a significant two-way interaction was observed between timeframe and valence (F (4,257) = 3.77, $p < 0.05$). Cell means show that those who forecasted only long-term consequences with both positive and negative valence generated the most original ideas (M = 2.38, SE = 0.11) compared to any other group.

Insert Table 13 About Here

Idea Evaluation

Table fourteen presents the ANCOVA results for idea evaluation depth. Planning skill (F (1,257) = 7.31, $p < 0.05$) was a significant covariate, proving to be positively related to depth of evaluations. No other significant results were observed here.

Insert Table 14 About Here

Table fifteen presents the ANCOVA results for idea evaluation usefulness. Planning skill (F (1,257) = 8.68, $p < 0.05$) was a significant covariate, proving to be positively related to usefulness of evaluations. Only a significant main effect for timeframe was observed (F (2,257) = 3.22, $p < 0.05$). Cell means indicated that those who forecasted only long-term consequences had more useful evaluations ($M = 2.05$, $SE = 0.06$) than participants who forecasted only short-term consequences ($M = 1.83$, $SE = 0.06$) or both long- and short-term consequences ($M = 1.99$, $SE = 0.06$).

Insert Table 15 About Here

Final Plan

Table sixteen presents the ANCOVA results for quality of final plan. Planning skill (F (1,257) = 8.98, $p < 0.05$) was a significant covariate, proving to be positively related to plan quality. A significant (F (2,257) = 5.57, $p < 0.05$) main effect for valence was obtained. Inspection of cell means indicated that those who forecasted only negative outcomes had higher quality plans ($M = 2.46$, $SE = 0.05$) than participants who forecasted only positive outcomes ($M = 2.23$, $SE = 0.06$) or both positive and negative outcomes ($M = 2.25$, $SE = 0.06$).

Insert Table 16 About Here

Table seventeen presents the ANCOVA results for originality of final plan. Planning skill (F (1,257) = 7.10, $p < 0.05$) was a significant covariate, proving to be positively related to plan originality. A significant main effect for timeframe was observed (F (2,257) = 9.97, $p < 0.001$). Cell means indicated that those who forecasted only short-term consequences had more original plans (M = 2.47, SE = 0.06) than participants who forecasted only long-term consequences (M = 2.12, SE = 0.06) or both long- and short-term consequences (M = 2.44, SE = 0.06). A significant main effect of valence was also seen (F (2,257) = 7.21, $p < 0.001$). Cell means indicate that those who forecasted only negative outcomes had more original plans (M = 2.52, SE = 0.06) than participants who forecasted only positive outcomes (M = 2.32, SE = 0.06) or both positive and negative outcomes (M = 2.20, SE = 0.06).

A significant two-way interaction was also observed between timeframe and valence (F (4,257) = 8.77, $p < 0.001$). Inspection of cell means indicate that those who forecasted both positive and negative outcomes with only a negative valence had the most original plans (M = 2.95, SE = 0.11) compared to any other group.

Insert Table 17 About Here

Table eighteen presents the ANCOVA results for elegance of final plan. No significant covariates were observed. However, a significant main effect for valence was seen (F (2,257) = 5.80, $p < 0.05$). Cell means indicate that those who forecasted only negative outcomes had more elegant plans (*M* = 2.62, *SE* = 0.06) than participants who forecasted only positive outcomes (*M* = 2.42, *SE* = 0.06) or both positive and negative outcomes (*M* = 2.34, *SE* = 0.06).

Insert Table 18 About Here

Discussion

Before turning to the broader implications and key findings of this effort, a few limitations should be noted. The present study was based on a low-fidelity experimental task where undergraduates took on the role of a restaurant development manager for a restaurant consulting company. Although, it has been seen that this creative task is appropriate and engaging for undergraduate students because of their experience with restaurants (Medeiros et al., 2018), the generalizability of these findings to professionals tasked with creative work in a real-world work setting remains uncertain. Similarly, although the restaurant scenario provided to participants was fairly realistic, an actual restaurant development effort would be more complex.

Along related lines, a low-fidelity simulation was used in this study because this type of design provides more control over extraneous variables which influence forecasting and creative performance. Put differently, to ensure the viability of the creative exercise, the experimental manipulations needed to be presented in a fixed order. Forecasting manipulations were introduced only prior to problem identification. In real-world creative efforts, forecasting may occur at multiple time points, both early and later on in the creative process. Moreover, participants worked through the task at their own pace, and the amount of time spent forecasting or addressing any of the creative process prompts was not measured or manipulated.

Lastly, given the design that was utilized in this effort, the timeframe in which creative problem-solving efforts took place was limited. Creative efforts oftentimes take numerous months or years to unfold, so a more longitudinal and in-depth approach to examining this study's research questions may yield differing results.

Even with these with these limitations in mind, the present study still provides valuable insight into how forecasting impacts creative performance. This study addresses a gap in the literature by investigating how forecasting early in the creative process impacted subsequent creative cognitions. Additionally, this effort explores how forecasting valence and forecasting timeframe relate to both creative solving processes and final creative output if forecasting occurs early. Overall, the variables examined in the present effort demonstrated significant influence at various points throughout the creative process.

The first set of findings of note are related to forecasting extensiveness and forecasting quality. Both extensiveness and quality of forecasts were shown to be strongly related to better creative performance, as marked by higher quality, more original, and more elegant final plans. These findings are in line with previous studies by Shipman et al. (2010) and Strange and Mumford (2005) which also saw that forecasting extensiveness was positively related to quality, originality, and elegance of final plans. Observations with respect to forecasting quality and participant plans provide additional support for the studies concluding that effective forecasting is of value when solving problems requiring creativity (e.g., Byrne et al., 2010; Marta et al., 2005; Osburn & Mumford, 2006). Forecasting, therefore, is an impactful variable when it comes to creative performance, and support for our first and second hypotheses is present.

A second set of findings which should be underscored is with respect to the exploratory nature of this study. There is very little research examining the impact of timing of forecasting on creative performance. Only one study (i.e., McIntosh et al., 2021) addressing this topic was found when reviewing the literature. The findings of McIntosh et al. (2021) provided some evidence for the claim that forecasting early benefits subsequent stages of creative cognition; however, this study examined the impact of forecasting early on idea generation and idea evaluation, which are both "late stages" of the eight-stage model. Thus, there no research examining the impact of forecasting during "early stages" on subsequent stages and creative performance exists. To that end, in the present effort, forecasting was prompted during problem identification, an early stage of the eight-stage model put forth by Mumford et al. (1991). It was seen that forecasting extensiveness was significantly positively correlated with all the creative processes in the eight-stage model (i.e., problem identification, information gathering, concept selection, conceptual combination, idea generation, and idea evaluation) with correlations ranging from 0.22 to 0.59. Forecasting quality saw a similar pattern of findings, with significant positive correlations with all eight stages ranging from 0.27 to 0.67. These results provide initial evidence for the claim that forecasting in the early stages of the eight-stage model provides benefits for subsequent creative processes while also addressing a large gap in the creativity literature. Future studies should further examine the impacts of forecasting early. In the present study forecasting was embedded at the problem identification stage, researchers should examine whether embedding forecasting into an alternate early-stage process yields different results. In this study all participants forecasted early, thus, there was no means of comparing creative output of those who forecasted early with those who didn't. Future efforts should examine the differences in creative output between participants who forecast early and those who forecast later in the creative process.

The next set of findings warranting mention are related to forecasting timeframe. Specifically, it was seen that when forecasting early, long-term time frame was beneficial to many creative processes. Specifically, quality of information gathering, quality of concept selection, quality and originality of ideas generated, and usefulness of idea evaluations were all rated higher for participants forecasting with only a long-term time frame. Forecasting both long-term and short-term consequences was seen to be beneficial for problem identification, but only when participants also attended to positively valenced outcomes. Short-term forecasting, on its own, did not seem to benefit creative problem solving.

Relatedly, findings for positively valenced outcomes should be mentioned. It was seen that positive valence improved execution of certain creative processes. More specifically, forecast quality, conceptual combination quality, and conceptual combination originality were all rated higher for those who focused only on positive outcomes in their forecasts. Focusing on both positive and negative outcomes was seen to only benefit concept selection quality. Taken together, the findings for long-term forecasting time frame and positive forecasting valence reveal something noteworthy. That is, when forecasting early, thinking long-term and thinking positively benefits the processes of creative problem solving.

The last set of findings discussed here are with respect to negatively valenced forecasts. Negative valence was seen to benefit every aspect of the final plan generated by participants. Put differently, the final plans with the highest ratings of quality, originality, and elegance all resulted from participants who only focused on negative outcomes. So, while focus on positive outcomes benefitted processes, a focus on negative outcomes benefitted the final product. In a more global sense, these findings address the debate in the creativity literature regarding affect and creative performance (Anderson et al., 2014; James et al., 2009). The findings from the present effort reveal that it is not the case that positive affect is better than negative affect for creative performance. Instead, it is important to distinguish the impact that affect has on the process vs. the product; A finding which is in line with the observations of Antes and Mumford (2012) and Baas et al. (2008). Future researchers should examine the distinction between process and product further, in order to distinguish when and where in the creative process positive and negative affect should be utilized in order to yield the most effective creative cognition and subsequent creative output.

Conclusion

The present study contributes to the creativity literature in many ways. First, this effort provides additional validation data for research suggesting that characteristics of forecasting such as extensiveness and quality, benefit creative performance (e.g., Shipman et al., 2010). Second, this study addresses a large gap in the forecasting and creative problem-solving literature and provides some initial evidence for the benefit of forecasting in the early stages of creative cognition. Third, the findings of the present effort suggest that thinking positively is not necessarily the best approach to creativity. It was seen that positive valence benefitted creative *processes* such as forecasting quality and conceptual combination. However, positive valence had no such benefits for the *final plan or product*. Instead, negative valence was seen to related to higher quality plans, more original plans, and plans which were more elegant. This finding provides some answers to the debate in the creativity literature regarding whether positive or negative affect enhances creativity.

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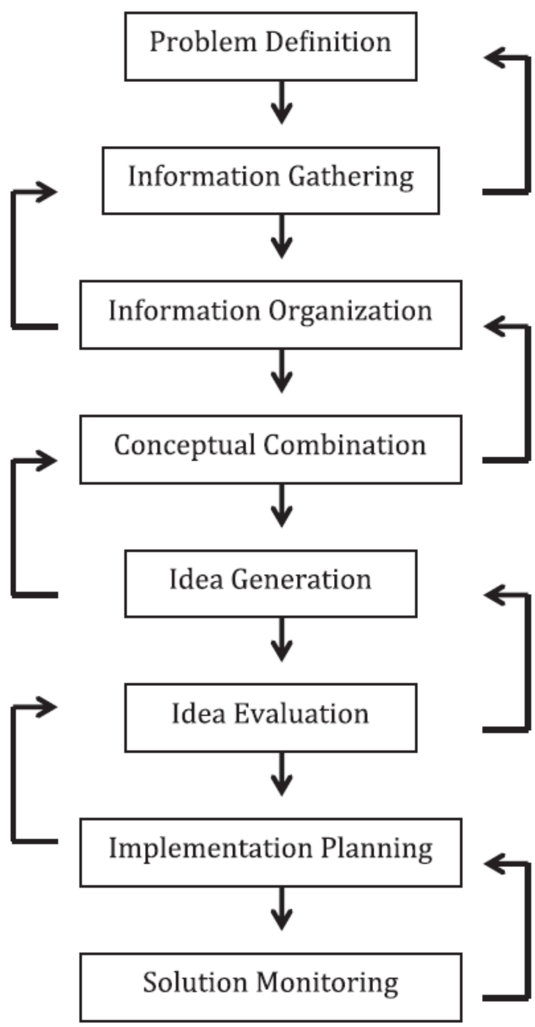
Figure 1

Eight-Stage Creative Thinking Model



Note. Figure taken with permission of the authors.

Table 1

Correlation Matrix for All Covariates and Dependent Variables

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1. Intelligence	23.17	8.11	--																									
2. Divergent Thinking	5.57	2.36	.12	--																								
3. Need for Cognition	3.13	0.60	.05	-.06	--																							
4. Planning Skill	5.15	2.67	.23**	.17**	.14*	--																						
5. Neuroticisim	3.25	0.67	.05	.06	-.18**	-.06	--																					
6. Extraversion	3.46	0.64	-.11	.07	.11	-.06	-.19**	--																				
7. Openness	3.24	0.55	.18**	.02	.45**	.16**	.07	-.05	--																			
8. Agreeableness	3.50	0.54	.06	.09	.05	.13*	-.11	.34**	.03	--																		
9. Conscientiousness	3.56	0.58	-.11	.10	.25**	.05	-.27**	.29**	-.06	.29**	--																	
10. Problem ID Number of Contraints	2.22	0.68	.02	.06	.05	.15*	.02	-.07	.03	.07	.02	--																
11. Problem ID Quality	2.26	0.61	.09	.10	.11	.24**	-.05	-.08	.09	.12	.08	.72**	--															
12. Forecast Short Term	1.79	0.43	.03	.11	.08	.17**	.01	-.01	.08	.07	.07	.27**	.47**	--														
13. Forecast Long Term	2.01	0.61	.06	.07	.01	.18**	.03	-.07	.11	.10	.01	.26**	.55**	.50**	--													
14. Forecast Extensivenss	1.94	0.57	.07	.04	.04	.20**	.03	-.07	.12*	.12	.05	.37**	.59**	.67**	.78**	--												
15. Forecast Quality	1.99	0.58	.07	.07	.01	.24**	.01	-.07	.09	.12	.03	.42**	.67**	.73**	.80**	.89**	--											
16. Information Gathering Quality	2.17	0.53	.15*	.20**	.04	.18**	-.01	-.09	.08	.17**	.00	.37**	.50**	.34**	.40**	.37**	.42**	--										
17. Concept Selection Quality	1.97	0.50	.08	.15*	.05	.16**	.05	-.07	.18**	.08	.04	.24**	.44**	.39**	.46**	.41**	.45**	.62**	--									
18. Conceptual Combination Quality	2.53	0.49	.09	.12*	.06	.20**	-.03	-.02	.07	.10	.06	.35**	.52**	.31**	.54**	.45**	.46**	.49**	.52**	--								
19. Conceptual Combination Originali	2.25	0.60	-.01	.03	.04	.17**	-.06	.07	.00	.09	.02	.30**	.41**	.15*	.30**	.22**	.27**	.30**	.30**	.62**	--							
20. Idea Generation Quality	2.10	0.55	.13*	.09	.12	.21**	-.03	-.05	.13*	.07	.10	.27**	.42**	.29**	.35**	.37**	.41**	.27**	.47**	.52**	.39**	--						
21. Idea Generation Originality	2.11	0.63	.07	.08	.11	.09	-.02	.00	.02	.02	.09	.24**	.33**	.12*	.35**	.30**	.32**	.22**	.27**	.40**	.29**	.73**	--					
22. Idea EvaluationDepth	2.08	0.65	.12	.11	.09	.17**	.06	-.02	.09	.07	-.03	.26**	.38**	.25**	.23**	.32**	.35**	.41**	.38**	.46**	.37**	.49**	.33**	--				
23. Idea Evaluation Usefulness	1.97	0.60	.11	.06	.05	.17**	.07	-.01	.06	.09	-.05	.35**	.42**	.25**	.31**	.35**	.40**	.39**	.34**	.51**	.43**	.50**	.37**	.88**	--			
24. Final Plan Quality	2.32	0.53	.07	.14*	.09	.17**	.08	-.10	.11	.09	.00	.35**	.42**	.22**	.27**	.29**	.23**	.40**	.41**	.47**	.37**	.46**	.32**	.39**	.37**	--		
25. Final Plan Originality	2.33	0.64	.04	.04	.07	.14*	.06	.02	.10	.09	.02	.24**	.24**	.13*	.27**	.29**	.25**	.22**	.27**	.32**	.44**	.39**	.42**	.23**	.30**	.63**	--	
26. Final Plan Elegance	2.45	0.58	.03	.14*	.03	.15*	.08	-.08	.07	.08	.04	.34**	.39**	.24**	.32**	.31**	.29**	.33**	.43**	.46**	.39**	.46**	.36**	.35**	.34**	.87**	.72**	--

*$p < .05$. **$p < .01$.

Table 2

ANCOVA Results for Number of Constraints in Problem Identification

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	3.87	1	3.87	10.21	.00	.04
Main Effects						
Valence	10.52	2	5.26	13.86	.00	.09
Interactions						
Timeframe*Valence	8.27	4	2.07	5.45	.00	.08

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 3

ANCOVA Results for Quality of Problem Identification

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	6.03	1	6.03	18.29	.00	.07
Interactions						
Timeframe*Valence	6.93	4	1.73	5.25	.00	.08

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 4

ANCOVA Results for Short-Term Forecasting

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	1.49	1	1.49	9.45	.00	.04
Main Effects						
Valence	4.45	2	2.23	14.07	.00	.09

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 5

ANCOVA Results for Long-Term Forecasting

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	3.07	1	3.07	9.24	.00	.04
Main Effects						
Valence	2.21	2	1.11	3.34	.04	.03
Interactions						
Timeframe*Valence	5.10	4	1.28	3.84	.00	.06

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 6

ANCOVA Results for Extensiveness of Forecasting

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	2.88	1	2.88	10.01	.00	.04
Interactions						
Timeframe*Valence	5.62	4	1.41	4.89	.00	.07

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 7

ANCOVA Results for Quality of Forecasting

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	4.86	1	4.86	16.11	.00	.06
Main Effects						
Valence	3.42	2	1.71	5.66	.00	.04

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 8

ANCOVA Results for Quality of Information Gathering

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Divergent Thinking	2.49	1	2.48	10.51	.00	.04
Agreeableness	1.56	1	1.56	6.59	.01	.03
Main Effects						
Valence	1.69	2	.84	3.56	.03	.03
Interactions						
Timeframe*Valence	4.92	4	1.23	5.18	.00	.08

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 9

ANCOVA Results for Quality of Concept Selection

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Divergent Thinking	1.69	1	1.69	8.37	.00	.03
Openness	1.47	1	1.47	7.29	.00	.02
Main Effects						
Timeframe	4.61	2	2.31	11.41	.00	.08
Valence	1.91	2	0.95	4.73	.01	.04
Interactions						
Timeframe*Valence	4.69	4	1.17	5.81	.00	.08

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 10

ANCOVA Results for Quality Conceptual Combination

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	2.21	1	2.23	10.22	.00	.04
Interactions						
Timeframe*Valence	4.16	4	1.04	4.81	.00	.07

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 11

ANCOVA Results for Originality of Conceptual Combination

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	2.77	1	2.77	8.79	.00	.03
Main Effects						
Timeframe	3.29	2	1.65	5.22	.00	.04
Interactions						
Timeframe*Valence	10.31	4	2.58	8.18	.00	.11

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 12

ANCOVA Results for Quality Idea Generation

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	2.65	1	2.65	9.68	.00	.04
Main Effects						
Timeframe	2.21	2	1.10	4.03	.02	.03

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 13

ANCOVA Results for Originality of Idea Generation

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Main Effects						
Timeframe	4.12	2	2.06	5.61	.00	.04
Interactions						
Timeframe*Valence	5.53	4	1.38	3.77	.00	.06

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 14

ANCOVA Results for Depth of Idea Evaluation

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	2.95	1	2.95	7.31	.00	0.03

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 15

ANCOVA Results for Usefulness Idea Evaluation

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	2.88	1	2.88	8.67	.00	.03
Main Effects						
Timeframe	2.14	2	1.07	3.22	.04	.02

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 16

ANCOVA Results for Quality of Final Plan

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	2.42	1	2.42	8.98	.00	.03
Main Effects						
Valence	3.00	2	1.50	5.57	.00	.04

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 17

ANCOVA Results for Originality of Final Plan

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Significant Covariates						
Planning Skill	2.38	1	2.38	7.09	.00	.02
Main Effects						
Timeframe	6.70	2	3.35	9.97	.00	.07
Valence	4.84	2	2.42	7.21	.00	.05
Interactions						
Timeframe*Valence	11.78	4	2.94	8.77	.00	.12

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.

Table 18

ANCOVA Results for Elegance of Final Plan

	SS	*df*	*MS*	*F*	*Sig.*	η_p^2
Main Effects						
Valence	3.75	2	1.87	5.79	.00	.04

Note. SS = Type III Sum of Squares, df = degrees of freedom, MS = Mean F-ratio, p = significance level, η_p^2 = effect size estimate.