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The Downstream Consequences of Problem-Solving Mindsets:
How Playing with Legos Influences Creativity

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Abstract

Business leaders, governments, and scholars are increasingly recognizing the importance of creativity. Recent trends in technology and education, however, suggest that many individuals are facing fewer opportunities to engage in creative thought as they increasingly solve well-defined (versus ill-defined) problems. Using three studies that involve real problem-solving activities (e.g., putting together a Lego kit), the authors examine the mindset created by addressing such well-defined problems. The studies demonstrate the negative downstream impact of such a mindset on both creative task performance and the choice to engage in creative tasks. The research has theoretical implications for the creativity and mindset literatures as well as substantive insights for managers and public-policy makers.

Keywords: Creativity, Mindsets, Problem-Solving, Divergent Thinking

Business leaders, governments, and scholars are increasingly recognizing the importance of creativity. In a recent poll of 1500 CEOs, creativity was rated as *the* most important leadership quality needed by their institutions through 2015, trumping even integrity and global thinking (Carr 2010). Creative leaders, according to the IBM Global CEO survey, are those who embrace ambiguity and are committed to experimentation. Recent trends in technology and education, however, suggest that the opportunities to engage in this type of exploratory thinking may be declining for a number of individuals. Google provides immediate answers, teachers “teach to the test,” and over-scheduled lives leave fewer opportunities to discover or pursue new interests. Essentially, many of the problems we face on a daily basis are becoming increasingly more structured and well-defined. Nowhere is this shift more evident than in the toy aisle. What used to be a staple of childhood, a box of loose Lego’s bricks and pieces, has been crowded out on the store shelves by the company’s themed kits. Rather than challenging consumers to solve an ill-defined problem (e.g., “build something”), the kits present them with a well-defined problem along with the means to solve it (e.g., “build this Imperial Palace using this set of bricks and pieces while following the sequence specified in these step-by-step instructions”). The double-digit growth in the company’s revenues indicates that consumers have a strong desire to solve these types of well-structured problems (Hansegard and Burkitt 2013).

When consumers solve these well-structured problems, are there downstream implications for their creative performance on subsequent tasks? Our research addresses this question using three studies that examine the mindset created by solving well-defined (versus ill-defined) problems. We demonstrate the downstream influence of problem-solving mindsets on individuals’ creative performance as well as their choice to engage in creative tasks.

While consumer researchers have highlighted the influence of different mindsets on consumers' product evaluations (Monga and Gurhan-Canli 2012; Ülkümen, Chakravarti, and Morwitz 2010; Xu and Wyer 2012; Yang et al. 2011), decision processes (Levav, Reinholz, and Lin 2012; Xu, Jiang, and Dhar 2013), and motivation (White, MacDonnell, and Dahl 2011; Wyer and Xu 2010), few studies have considered the influence of a consumer's mindset on creative task performance. Our research does just that by engaging participants in real problem-solving activities (e.g., putting together a Lego kit) and identifying the negative influence that solving such well-defined problems has on an individual's creativity in a subsequent task. This finding is novel, given that the majority of research examining the determinants of creativity has focused only on the situational factors that enhance it, not undermine it (e.g., Burroughs et al. 2011; Goldenberg, Mazursky, and Solomon 1999; Moreau and Dahl 2005).

Our research also considers the influence of consumers' problem-solving mindsets on whether or not they choose to engage in a task that requires creative thought. To date, little research in the mindset literature has focused on consumers' choices of subsequent tasks. Rather, the norm is to specify a given task and examine the effects of different mindsets on consumers' evaluation processes, decisions, and/or behaviors. Understanding the conditions under which consumers *choose* to think creatively is important, as most experimental studies examining creativity simply assign participants to a given task (e.g., "make a cookie," Dahl and Moreau 2007).

PROBLEM-SOLVING MINDSETS

Recent research on mindsets has demonstrated that an individual's behavior or thought processes in one situation can influence their thoughts and behaviors in later, unrelated tasks. These spillover effects are thought to occur because the judgmental criteria, goals, and/or cognitive processes activated in one setting are accessible and, therefore, likely to be recruited for use in later situations (Malkoc, Zauberan, and Bettman 2010; Smith 1994). We argue that the cognitive activities required for problem-solving will create a mindset that endures over time and contexts.

What are the cognitive activities that occur during problem-solving? Problem-solving occurs within the context of a problem space which is defined "as how a solver represents or structures a given problem" (Newell and Simon 1972; Stokes 2007, p. 108). These problem spaces are comprised of three parts: (1) the problem itself (the initial state), (2) the set of operators (rules and strategies) which are deployed in sequence to move from the initial state to (3) the goal state (the solution) (Stokes 2007, p. 108; see also Leighton and Sternberg 2012, p.646; Newell and Simon 1972; Simon1999; Sternberg 2009). The extent to which information is known or provided about these three different aspects of the problem determines how well the problem is structured, and thus, where the problem lies on the continuum from well-defined to ill-defined (Shin, Jonassen, and McGee 2003).

Well-Defined Problem-Solving

Well-defined problems are characterized by full-information in which the solver has access to a clearly specified initial state, a known goal state, and, importantly, a known set of processes that enable a person to progress towards the goal (Finke, Ward, and Smith 1992; Leighton and Sternberg 2012; Newell and Simon 1972; Reitman 1965; Stokes 2007). Well-

defined problems tend to have “correct, convergent answers” (Jonassen and Kwon 2001, p. 36). Multiplication problems and jigsaw puzzles, for example, are prototypical of well-defined problems (Finke et al. 1992; Stokes 2007). Both have a clear initial state (i.e., two numbers that need to be multiplied together; a set of puzzle pieces that need to be assembled), a known set of processes or sequence of operations to achieve the goal (i.e., multiply the “ones” digit and carry if needed; identify and connect all the pieces with straight edges), and a predetermined goal state (i.e., the correct answer; a match with the picture on the puzzle box) (Finke et al. 1992; Stokes 2007).

Convergent thinking is most effective in solving well-defined problems because it “emphasizes speed, accuracy, <and> logic” in pursuit of “the single best (or correct) answer to a clearly defined question” (Cropley 2006, p.391). We argue that it is this aspect of convergent thinking - the search for the right solution - that defines the mindset associated with a well-defined problem. In his famous TED talk,² creativity expert Sir Ken Robinson argues that “schools kill creativity” by emphasizing performance on problems that have singularly correct answers. Robinson claims that this focus creates a fear of failure which detracts from our willingness to take risks associated with creative thoughts. Thus, we define a well-defined problem-solving mindset as one characterized by convergent thought processes deployed to find the correct solution as efficiently as possible (Cropley 2006).

Ill-Defined Problem-Solving

At the other end of the spectrum lie ill-defined problems, which lack all or most of the information required to reach a solution (Simon 1973; Stokes 2007; Voss and Post 1988). Ill-defined problems (e.g., “how can recycling be improved?”) have a myriad of potentially

satisfactory solutions and means for achieving them (Finke et al. 1992). All three elements in the problem space may be ambiguous. The initial state may be understood or interpreted in a number of different ways, some of which make it easier or harder to resolve (Hèlie and Sun 2010; Pols 2002). For example, one could interpret the recycling problem at various levels of magnitude (recycling efforts at our own home, in our city, in the U.S., or across the globe) or scope (paper, metal, containers, batteries, electronics, or vehicles). The set of operators needed to move along the path from the initial state to the goal state may also be unclear, and the end goal itself may not be clearly defined. Consequently, divergent thinking is most effective in solving these problems because it involves experimentation to identify and develop multiple ideas, each of which could potentially serve as a solution (Cropley 2006).

To produce these different candidate solutions, individuals' divergent thinking involves the use of the cognitive processes described by the Geneplore model (Finke et al. 1992; see also Cropley 2006; Hèlie and Sun 2010). According to this model, two key cognitive components are involved in the construction of a solution: generative and exploratory processes (Finke et al. 1992). First, individuals search for preliminary solutions and/or inputs to those preliminary solutions and generate ideas by “making unexpected combinations, recognizing links among remote associates, and transforming information into unexpected forms” (Cropley 2006, p. 391; Finke et al. 1992, p. 19; Hèlie and Sun 2010). Once those candidate solutions are established, exploratory processes are used to interpret and evaluate the options and to attach meaning to them (Finke et al. 1992; Moreau and Dahl 2005).

Ambiguity is a hallmark of ill-defined problems. The initial state (the problem itself) is open to interpretation, the operators (the cognitive strategies needed to generate the solutions) are not stipulated, and the goal state (the solution) is only reached by developing and applying a set

of evaluative criteria to select a candidate solution. Because creativity is considered to be a “special class of problem solving characterized by novelty, unconventionality, persistence, and difficulty in problem formulation” (Newell, Shaw, and Simon 1962, p. 66), solving an ill-defined problem can be considered an act of creative thinking. We argue that it is the cognitive activities of divergent thinking, exploration, and experimentation that define the mindset associated with an ill-defined problem. Table 1 summarizes the differences between ill-defined and well-defined problem spaces.

Insert Table 1 about here

CONSEQUENCES OF PROBLEM-SOLVING MINDSETS

Recently activated mindsets are easily accessible and therefore likely to be used in subsequent situations. Whether the activated mind-set will be conducive to solving the subsequent problem depends on how appropriate the accessible cognitive strategies are for the subsequent task (e.g., Xu, Jiang, and Dhar 2013). In the case of problem-solving mindsets, subsequent task performance likely depends on where that subsequent task lies on the continuum of well-defined to ill-defined problems, and importantly, how well it matches with the problem-solving mindset activated in the initial task. If a match exists, there may be little effect on subsequent task performance. However, if a mis-match exists, there will likely be a decline in performance on a subsequent task if the solver carries over a set of procedures incompatible with those required for successful task completion. More formally,

H1a: A well-defined problem-solving mindset will decrease performance on a subsequent ill-defined (creative) task but have little influence on performance in a subsequent well-defined task.

H1b: An ill-defined problem-solving mindset will decrease performance on a subsequent well-defined task but have little influence on performance in a subsequent ill-defined (creative) task.

STUDY 1

To test these hypotheses, 136 undergraduate students (57% male) participated in this 3 (problem-solving mindset: well-defined vs. ill-defined vs. control) X 2 (secondary task: ill-defined vs. well-defined) between-participant experiment in exchange for course credit. The experimental sessions lasted for 30 minutes and contained groups of five to ten participants. Upon entering the lab, participants sat at individual cubicles with 3-foot dividers, providing them with a private space in which to complete the study. With the exception of those in the control condition, participants received an initial task designed to instantiate a problem-solving mindset before proceeding to a subsequent, unrelated task that was either a well-defined or an ill-defined problem. Performance on this secondary task was the focal dependent measure.

Instantiating Problem-Solving Mindsets

We gave participants in both the well- and ill-defined problem-solving conditions the cover story that the Lego company was interested in understanding how adult consumers reacted to their products. In the well-defined condition, participants were given a Lego kit containing approximately 40 pieces and were asked to build it (see Web Appendix A). Step-by-step instructions described how to achieve the singular solution. In contrast, those in the ill-defined condition were given a bag of approximately 40 Lego bricks and pieces and asked “to build something.” Both groups spent 15 minutes engaged in the activity and then proceeded to the secondary task – the Torrance Test of Creative Thinking or the Miller Analogy Task. We told

participants in the control condition that the study related to college students' thoughts and opinions, and we asked them to complete only the secondary task.

Pretests

We conducted two pretests to examine whether factors other than induced problem-solving mindset could influence performance on the subsequent task. The first pre-test examined whether depletion could serve as a possible alternative explanation given that the first tasks could leave participants with differing levels of available cognitive resources for the second tasks (Hamilton et.al. 2011). The second pre-test focused on additional factors that could potentially explain any observed differences in subsequent task performance: affect, a factor that has been known to influence creative performance (e.g., Isen, Daubman, and Nowicki 1987); tolerance for ambiguity, a key individual difference variable that has been correlated with creativity (Tegano 1990); and sense of accomplishment and of completion, feelings that have been shown to result from engaging in self-design tasks (e.g., Franke, Schreier, and Kaiser, 2010).

Pretest 1: Depletion. In exchange for course credit, 76 undergraduates participated in this study and were randomly assigned to one of three initial task conditions: (1) the well-defined (Lego kit) problem-solving condition, (2) the ill-defined (Lego bricks) problem-solving condition, or (3) the control condition (no initial task). Following the initial task, participants solved a set of anagrams (Web Appendix B). Participants in the control condition simply began with the anagram task. The number of anagrams successfully completed served as the measure of task performance. We chose this type of depletion task because it tests for “a decrement in task performance” rather than persistence, thereby serving as a better indicator of depletion as a possible account for our performance results (Baumeister et al. 1998, p. 1258).

A one-way ANOVA was used to assess the influence of the initial task on participants' subsequent performance on the anagram task ($M = 6.57$; range: 1 – 15). The results revealed no significant influence of condition on anagram performance ($F(2, 73) = 1.66, p = .20$).

Participants who solved the well-defined problem solved 7.39 anagrams, those who solved the ill-defined problem solved 6.11, and those in the control condition solved 6.10. None of the contrasts was significant.

Pretest 2: Affect, Tolerance for Ambiguity, Accomplishment. In this pretest, 148 undergraduates were randomly assigned to one of the three initial task conditions described in Pretest 1. Following the initial task, participants responded to scales assessing affect and tolerance for ambiguity. Participants in the control condition simply started with these scales, and we counter-balanced the order in which these measures were presented. Because no significant differences in order emerged, we collapsed across the counter-balanced conditions in the analyses. Affect was measured using six items, three positive and three negative. On 9-point scales (anchored by “not at all” and “very”), participants reported the extent to which they felt happy, excited, enthusiastic, frustrated, stressed, and nervous. In an exploratory factor analysis, the items loaded on the two expected factors. Thus, we created two affect indices by averaging the three respective items to form a positive and a negative affect measure (α 's = .89 and .74, respectively). To assess the influence of the first task on participants' positive and negative affect ($M_{\text{positive}} = 5.62$; range: 2 – 9.0; $M_{\text{negative}} = 2.81$; range: 1 – 8.33), we used a one-way ANOVA which revealed no significant influence of condition on affect (positive: $F(2, 145) = 1.27, p = .28$; negative: $F(2, 145) = .01, p = .99$; see Table 2 for the full set of results).

Insert Table 2 about here

We measured tolerance for ambiguity using three items selected, based on relevance, from the most frequently used scale to measure the construct: the Bundy scale (1962) (Furnham and Marks 2013). On 5-point scales, participants indicated the extent to which they agreed with the following statements: “I prefer jobs where the task to be accomplished is clear;” “I get frustrated when people ask me to do tasks that are poorly defined;” “I feel that teachers or supervisors who give vague assignments provide a chance to show initiative”. The first two items were reverse-coded and the three were averaged to create an indicator of tolerance for ambiguity ($M = 2.37$; range: 1 to 4.33). A one-way ANOVA revealed a marginally significant influence of condition on tolerance for ambiguity ($F(2, 145) = 2.63, p = .08$), with participants in the control condition reporting a higher tolerance (2.60) than those in either the well-defined (2.31) or ill-defined problem-solving conditions (2.29). Recall that the control condition differed from the two problem-solving conditions in that the control participants answered these questions shortly after entering the lab, not after completing an initial task. It is possible that simply being under the experimenter’s instruction for a period of time marginally reduced participants’ ambiguity tolerance. Importantly, the well-defined and ill-defined conditions did not differ significantly from each other.

We measured participants’ sense of accomplishment using 9-point scales on which they indicated their agreement with the following statements: “I felt like I had accomplished a lot when I completed the task;” “I felt a strong sense of completion when I had finished the task;” and “I was proud of what I made out of the Legos.” The three items were averaged to form an index of accomplishment ($M = 5.37$; Range: 1 – 9; $\alpha = .87$). Participants in the control condition did not respond to these questions. A one-way ANOVA revealed no significant influence of

condition on participants' sense of accomplishment ($M_{\text{well-defined}} = 5.59$ vs. $M_{\text{ill-defined}} = 5.15$, $F(1, 114) = 1.41$, $p = .24$).

Secondary Tasks

Ill-defined (creative) task. As we have argued, solving an ill-defined problem can be considered an act of creative thinking because an individual often uses divergent thinking “to create, invent, discover, imagine, suppose, or hypothesize” (Sternberg 2006, p.325). A common test to assess creative ability is the Torrance Test of Creative Thinking (TTCT), the measure which identified the downward trend in creativity among U.S. schoolchildren (Torrance 1966; 1974). The Torrance test has been taken worldwide by millions and consists of a set of discrete tasks that involve divergent thinking (Bronson and Merryman 2010; Cramond, Matthews-Morgan, Bandalos, and Zuo 2005). The tasks on the Torrance test are designed to identify general mental abilities that are both involved in and predictive of creative achievements (Kim 2006; Runco et al. 2010; Cramond et al. 2005; Torrance 1966, 1974). Scoring of the test requires judges to assess responses based on originality, fluency, and elaboration (Runco et al. 2010). The predictive validity of the test has been verified by longitudinal studies assessing creative achievement (Cramond et al. 2005; Kim 2006).

In this study, we used two of the “incomplete figures” activities from the Torrance Test of Creativity for the creative task and presented them on two separate pages. The instructions asked participants to do the following: “In the space below (and on the next page), you will see two incomplete figures. Your task is to complete each of these figures by adding lines, curves, and any other details you’d like. Give your picture a title. You will have 4 minutes to complete

each figure” (see Web Appendix C). The experimenter timed the two tasks. Importantly, participants were not explicitly told to be creative in their drawings.

This task conforms with the definition of an ill-defined problem in that (1) the initial state is somewhat ambiguous given that it may be interpreted in a number of different ways, (2) the set of operators that will move an individual from the initial state to the goal state are not established, and (3) the goal state does not involve a “single, correct, predetermined” solution (Stokes 207, p. 108). Rather, there are an infinite number of solutions and a notable absence of a criterion for knowing when (or whether) the goal has been met (Stokes 2007).

Well-defined task. In this study, we chose the Miller Analogy Test (MAT) as the well-defined task. The MAT has been used to make admissions decisions by educational institutions and hiring or promotion decisions for higher level jobs in industry (Kuncel et al. 2004). We gave participants in this condition 25 analogy questions (see Web Appendix D) and told them that “this is a study on college students’ reasoning by analogy. You’ll be given 8 minutes to answer as many of the following as you can.” The experimenter timed this task as well.

This task conforms much more closely to the definition of a well-defined problem in that the initial state is quite clear and the goal state involves a single, correct solution. However, it is not as well-defined in terms of the operations required to achieve the goal state. In fact, analogical thinking has been identified as cognitive process underlying creative thought (e.g., Dahl and Moreau 2002). Thus, while this task is much closer to the well-defined end of the problem-solving continuum than the tasks drawn from the Torrance Test, it does contain some ambiguity in the processes needed to achieve the goal state.

Dependent Measures

Ill-defined (creative) task performance. To assess performance on the creativity task, we followed the guidelines established by Torrance (2003). The Torrance test items are designed to reflect different indicators of creative potential (Runco et al. 2010; Torrance 2003), and the relevant dimensions for the “incomplete figures” component of the test are 1) originality (the rarity / uniqueness of the drawing), 2) the abstractness of the title and 3) elaboration (the amount of detail in the drawing; see Runco et al. 2010; Torrance 2003).

Six sets of 8 judges rated the drawings, with each judge rating only one of the three dimensions for one of the two incomplete figures. The judges had completed a semester-long course on creativity, and therefore, had prior knowledge and experience related to the Torrance Test. Judges rated each drawing on 1-5 scales (with 5 being the highest level of the dimension), and their inter-judge reliabilities were high (all α 's > .81). To form the dependent measures, we first averaged the ratings on each dimension across judges for each of the two incomplete figures, yielding six average scores per participant (three per drawing). We then averaged across the two replicates. Because Torrance intended the dimensions to be relatively independent indicators of creativity, we used each of the three dimensions as dependent variables (Torrance 2003).⁴ However, we also converted each of the measures of originality, elaboration, and abstractness to a z-score and added them together for an overall creativity score, following the procedure described in Runco et al. (2010; $M = .10$, range = -4.65 to 4.59).

Well-defined task performance. Assessing participants' performance on the analytical test was more straightforward. We used two performance measures: 1) the number of correct responses ($M = 17.1$, range = 8 to 24), and 2) the percentage of correct responses out of the number attempted as not all participants completed the test within the allotted time frame ($M = 73\%$; range = 32% -100%).

Results

Ill-defined (creative) task performance. A one-way ANOVA revealed the main effect predicted by Hypothesis 1a ($F(2, 55) = 5.38, p < .01$). Participants tackling the well-defined problem received a lower creativity score ($M = -.91$) than either those solving the ill-defined problem ($M = .87; F(1, 55) = 9.87, p < .01$) or those in the control condition ($M = .44; F(1, 55) = 6.03, p < .05$). When we analyzed the separate dimensions (originality, elaboration, and abstractness of the title) independently, the results indicated that originality and abstractness were the main contributors to the overall effect. The main effects of the problem-solving mindset on both of these dimensions were significant (originality: $F(2, 55) = 7.2, p < .01$; abstractness: $F(2, 57) = 3.2, p = .05$), though the main effect on elaboration was not $F(2, 55) = 1.4, p > .10$). Consistent with the pattern found for overall creativity, participants in the well-defined condition scored lower on both originality and abstractness than their counterparts in the ill-defined condition ($M_{\text{originality, well-defined}} = 2.4$ vs. $M_{\text{originality, ill-defined}} = 3.2, F(1, 55) = 11.63, p < .01$); $M_{\text{abstractness, well-defined}} = 1.7$ vs. $M_{\text{abstractness, ill-defined}} = 2.3, F(1, 55) = 6.15, p < .05$) and lower than those in the control condition ($M_{\text{originality}} = 3.1, F(1, 55) = 10.18, p < .01$); $M_{\text{abstractness}} = 2.1, F(1, 55) = 2.77, p = .10$). A similar pattern emerged for elaboration, but did not approach significance ($M_{\text{well-defined}} = 2.4$ vs. $M_{\text{ill-defined}} = 2.8$ vs. $M_{\text{control}} = 2.7$; see Figure 1).

Insert Figure 1 about here

Well-defined task performance. We used a one-way ANOVAs to test Hypothesis 1b which predicted that an ill-defined problem-solving mindset would impair performance on a well-defined task. However, neither the model predicting the total number of correct answers nor

the one predicting the percentage correct revealed a significant effect (total correct: $F(2, 75) = 1.20$, n/s; percentage correct: $F(2, 75) = .09$, n/s). Participants in the ill-defined condition answered an average of 17.2 analogies (74.1%), a performance that was not significantly different from the 16.1 correct analogies (72.2%) answered by those in the well-defined condition or the 17.6 correct (73.8%) in the control condition. Thus, Hypothesis 1b was not supported. In hindsight, this result is not completely surprising given that the well-defined task did not fully conform to all three criteria. While the initial state and the goal state were well-defined in the analogy task, the process required to get from the initial state to the goal state were not stipulated. Since analogical thinking has been shown to underlie creative thought (e.g., Dahl and Moreau 2002), the mis-match between the analogy task and the loose Lego task was likely lower than the mis-match between the Torrance task and the Lego kit task.

Discussion

This study demonstrates that a well-defined problem-solving mindset can carry over to diminish performance on a subsequent ill-defined, creative task. Participants who had put together a Lego kit scored significantly lower on items from the Torrance Test of Creativity than either those who had built free-form with the Lego bricks or those in the control condition. Results from the two pretests indicate that depletion, affect, tolerance for ambiguity, and a sense of accomplishment are unlikely to explain the effects. Interestingly, the problem-solving mindset exerted its most significant influence on the dimensions of originality and title abstractness. Both of these dimensions result from novel patterns of thinking, while elaboration reflects greater persistence (Almeida et al. 2008; Kim 2006; Torrance 1966). Thus, the effect of the problem-solving mindset on creative performance appears to be more directly related to the carry-over of

cognitive processes rather than motivation. We test this explanation more directly in the following study.

As we better specify the processes underlying a problem-solving mindset, it is also crucial to identify which elements of the problem's structure are most influential on subsequent task performance. Given that the problem space contains three different parts (the initial state, the set of operators, and the goal state), one or more of these factors may differentially contribute to the mindset and its carry-over effects. In Study 1, both the goal state *and* the set of operators were fixed for those solving the Lego kit problem, while neither was fixed for those given the bag of loose Legos. Thus, it is unclear whether the presence of a single correct answer (a clearly-specified goal state) or a set of step-by-step instructions (a known set of operators) was responsible for the decline in creative task performance. In the following study, we manipulate these two factors independently in order to observe their distinct effects.

A known set of operators can help facilitate the speed and accuracy with which an individual moves towards a goal. However, if the goal state itself is unknown, there is ambiguity concerning where the individual is headed. Conversely, when the goal state is known, but there is no known set of operators to facilitate its achievement, there is ambiguity concerning the process of goal attainment. Thus, ambiguity can enter the problem-solving space in two different ways. We propose that it is knowledge of the goal state rather than knowledge of the set of operators that influences the cognitive processes associated with a problem-solving mindset, and is, therefore, responsible for the decline in performance in a subsequent creative task.

The rationale for this proposition is that goals focus attention, and in the process, objects that are unrelated to the goal are devalued (Brendl, Markman and Messner 2003). This finding suggests that the presence of a clear goal state discourages divergent thinking since exploration and

experimentation (i.e., attention focused on unrelated objects) are detrimental to efficient goal attainment. However, the knowledge of a known set of operators (in the absence of a known goal state) is less likely to diminish divergent thinking because the singular solution only emerges at the end of the process. Up until that point, any number of solutions could emerge, and curiosity about the goal state likely facilitates mental exploration as one considers a number of different possible outcomes. Thus,

- H2a: The presence of a known goal state (i.e., a target outcome) in the initial task will diminish creative performance in a subsequent task.
- H2b: In the absence of a known goal state, the presence of a known set of operators (i.e., instructions) will have little influence on subsequent creative performance.

STUDY 2

Design and Procedure

To test Hypothesis 2, 137 undergraduate students participated in this 2 (instructions: present vs. absent) X 2 (outcome: present vs. absent) between-participants experiment. The experimental sessions lasted for 30 minutes and contained groups of 10 to 15 participants. When the participants entered the lab, we informed them that they would be engaging in two different activities. As a cover story, we told all participants that the first study examined “how current college students respond to experiences that they had when they were younger” and that they would be engaging with Legos. We then told participants that they would be given a bag of Lego pieces and would be asked to make something out of them (the initial state).

Instructions. This construct was manipulated by either providing participants with the step-by-step instructions provided with the Lego kit or by withholding them.

Outcome. Participants were either given a picture of the outcome shown on the Lego box or they were not. For those who received the picture of the outcome, this manipulation made the initial state more clearly specified.

Dependent Measures

To separate the independent effects of motivation and divergent thinking, we used Guilford's unusual uses task, which asks participants to generate as many possible uses for a common household object (Guilford, Merrifield, and Wilson 1958). This measure of creativity is particularly useful because task performance is assessed based on both fluency (the number of uses generated) and originality (the novelty of the uses). The determinants of these two different outcomes, however, are likely to be different. Fluency is "an excellent measure of the motivation to be creative" because it reflects the effort participants devote to generating a set of alternative uses (Fitzsimons et al. 2008, p. 25). The originality of the uses, however, is more indicative of participants' divergent thinking (Finke et al., 1992).

In this study, all participants received the same secondary task – they were asked to generate as many uses for a paperclip as possible. We assessed fluency and originality using the scoring procedures outlined by Guilford (1967). We measured fluency by counting the number of uses generated by each person ($M = 5.79$; Range: 2 to 17). One participant generated 22 uses, a count that was approximately six standard deviations above the mean ($\sigma = 2.71$) and a significant outlier relative to the overall distribution. We removed this response from subsequent analyses. We measured originality by comparing each response to the frequency of its occurrence across participants. Specifically, a use that was mentioned by only 5% of the group was deemed "unusual" and received a single point while a use mentioned by only 1% of the

group was considered “unique” and received two points. Uses generated by more than 5% of respondents received zero points (Guilford 1967). Each participant’s originality score was created by adding the points earned by each of the uses they generated. Two judges independently computed these originality scores, and their correlation was high ($r = .91$). For the few cases where the scores diverged, the scoring was recomputed by a third judge, and the score agreed upon by two of the three judges was used in the analysis ($M = 1.41$; Range: 0 to 10).

Control Measure. The independent factors manipulated in this study were similar to those in Dahl and Moreau (2007) who found that participants enjoyed a cookie-making task to a greater extent when either a goal state (a target cookie) or a set of operators (step-by-step instructions) were present. As such, we measured process enjoyment to understand and to control for its potential influence on subsequent task performance. Following Dahl and Moreau (2007), participants indicated how much they enjoyed the Lego task and the extent to which they had a good time during the process, were satisfied with it, and were frustrated by it (reverse-coded). The four items were averaged to create an index of enjoyment ($M = 6.81$; Range: 1 – 9; $\alpha = .86$).

Results

Creative task performance. Two 2 (instructions: present vs. absent) X 2 (outcome: present vs. absent) ANOVAs were used to assess the effects of the independent factors on each of the two creative performance measures: originality and fluency. For originality, only a significant main effect of outcome emerged ($F(1, 132) = 5.57, p < .05$). Consistent with Hypothesis 2a, participants who were given a picture of the outcome in the first task produced less original uses for the paperclip as compared to those who did not receive a target outcome ($M_{\text{Outcome}} = 1.26$ vs. $M_{\text{No Outcome}} = 2.06$). Consistent with Hypothesis 2b, the presence of instructions

in the first task had no significant influence on the originality of the uses ($F(1, 132) = .19, n/s$). For fluency, no significant effects emerged (see Table 3 for a full reporting of the results).

Insert Table 3 about here

Control measure. A 2 (instructions: present vs. absent) X 2 (outcome: present vs. absent) ANOVA with task enjoyment as the dependent measure revealed significant main effects of both instruction and outcome. Participants given step-by-step instructions enjoyed the process more than those who did not received instructions ($M_{\text{instructions}} = 7.38$ vs. $M_{\text{no instructions}} = 6.26$; $F(1, 132) = 18.44, p < .01$). However, those who were given a picture of the outcome enjoyed the process less than those who were not ($M_{\text{Outcome}} = 6.42$ vs. $M_{\text{No Outcome}} = 7.22$; $F(1, 132) = 9.19, p < .01$). These main effects were qualified by an interaction ($F(1, 132) = 8.52, p < .01$) which demonstrated that a lack of step-by-step instructions was more detrimental to enjoyment when a target outcome was provided ($M_{\text{instructions, target outcome}} = 7.37$ vs. $M_{\text{no instructions, target outcome}} = 5.48$; $F(1, 132) = 17.70, p < .01$) rather than when it was not ($M_{\text{instructions, no target outcome}} = 7.40$ vs. $M_{\text{no instructions, no target outcome}} = 7.04$; $F(1, 132) = .95, n/s$). Despite the significance of these findings, a 2 (instructions: present vs. absent) X 2 (outcome: present vs. absent) ANCOVA with originality as the dependent measure and task enjoyment included as a covariate revealed only a main effect of outcome on originality ($F(1, 132) = 3.98, p < .05$). Task enjoyment did not significantly predict originality ($F(1, 132) = 1.29, n/s$).

Discussion

The results of this study offer additional insights into the process underlying problem-solving mindset carryover effects. First, by using the unusual uses task as a dependent measure,

we were able to provide further empirical support for our claim that well-defined problems create a mindset that carries over to impair divergent thinking, rather than motivation. Across the four conditions, there was little difference in the number of uses participants generated for the paperclip. However, there were significant differences in the originality of those ideas. Specifically, participants who were given a clear goal state (i.e., a picture of the completed Lego kit) produced significantly less original ideas than those for whom the goal state was uncertain.

Second, this study helps isolate the part of the problem-solving space responsible for the effects. Giving participants instructions (a known set of operators) in the first task did not significantly influence their creative performance on the second task. However, giving them a picture of the outcome (a clear goal state) was detrimental to creativity. Together, these findings support our initial claim that the search for the “right” solution diminishes divergent thinking, thereby reducing creative performance on a subsequent task. A third insight that emerges from these findings is that process enjoyment, while influenced significantly by our manipulations, had no significant influence on creative performance. When controlling for these affective responses to the task, the influence of the clear goal state remains significant.

In both Studies 1 and 2, we assigned all of the participants to a secondary task rather than giving them a choice of tasks to complete. The primary focus of these studies was the effect of the activated problem-solving mindset on subsequent task performance. Essentially, participants were concentrating on *how* to complete the given task rather than *why* they were engaged in it. This distinction is described by Lewin et al. (1944) as the difference between “goal-setting” and “goal-striving” (Gollwitzer et al. 1990). In goal striving, individuals focus on how to implement the established goal and rely on information that is useful for task completion (Gollwitzer 1990).

Therefore, activated procedures or strategies that are potentially relevant for task completion (e.g., convergent thinking) are likely to be implemented.

In goal-setting, however, individuals are selecting among different types of actions in which to engage. In these choice situations, the emphasis is on deliberation rather than implementation as people weigh the pros and the cons of engaging in different tasks or activities (Gollwitzer 1990; Gollwitzer and Moskowitz 1996). The desirability of the different possible outcomes and the feasibility of achieving those outcomes are the most significant criteria used to determine choice (Gollwitzer 1990). How, then, do activated problem-solving mindsets influence an individual's choice of a subsequent task? We address this question in Study 3.

PROBLEM-SOLVING MINDSETS AND TASK CHOICE

While researchers have consistently demonstrated that activated behavioral mindsets can affect choice within the context of a subsequent task, the subsequent task itself is typically held constant across participants (see Wyer and Xu 2010). As such, research on behavioral mindsets and choice have largely examined goal striving, not goal setting. For example, Ülkümen et al. (2010) manipulate participants' exposure to broad versus narrow categories and examine the effect of this manipulation on a subsequent sorting task, finding that those initially exposed to broad categories subsequently created fewer groups of fruit (Study 1). In contrast, our focus is on the effects of an activated problem-solving mindset on individuals' *goal setting*. We examine the mindset's influence on the type of task in which the individual subsequently chooses to engage (well-defined versus ill-defined).

In reality, consumers often find themselves in a position of goal setting when choosing between ill-defined problems and well-defined ones. For example, a consumer who is planning to prepare dinner can choose between cooking from scratch (solving an ill-defined problem) and microwaving a frozen dinner (solving a well-defined problem). Increasingly, firms are offering a range of products to assist consumers with either choice. The General Mills' brand portfolio, for example, includes both Gold Medal flour and Macaroni Grill frozen meals. The way in which the consumer chooses between these different goals is by evaluating both the desirability and feasibility associated with the outcomes of each of the different options (Gollwitzer 1990). As we have argued, well-defined problem-solving mindsets are characterized by a search for a single, correct, and/or appropriate answer. Consequently, individuals with that mindset activated are likely to place significant weight on the *feasibility* dimension, focusing on the certainty with which they expect to accomplish a goal. Given their established procedures and defined ending points, well-defined problems are likely to rate higher on the feasibility dimension than ill-defined problems.

In addition to an activated mindset, consumers' chronic orientations can influence the goals they choose to pursue. For example, a consumer's self-perceived creativity could influence judgments of both the desirability and feasibility of different tasks. Specifically, individuals with higher self-perceived creativity are likely to find the ill-defined task more desirable than those with lower self-perceived creativity because actively choosing the more creative task can reinforce their identity as a creative person (Dahl and Moreau 2007; Dhar and Wertenbroch 2012). Self-perceived creativity could also influence the perceived feasibility of ill-defined tasks, as consumers who consider themselves to be more creative may have greater confidence in their ability to satisfactorily complete a creative task (Burroughs and Mick 2004). Thus, we propose

that a negative relationship exists between a consumer's self-perceived creativity and their choice of a well-defined task.

The effect of a problem-solving mindset and that of a chronic orientation may not occur independently of each other. A consumer's self-perceived creativity could moderate the effect of the problem-solving mindset on their choice of a subsequent task or overwhelm it completely. Individuals with higher levels of self-perceived creativity may be less influenced by the mindset carryover effects than those with lower perceived levels of the trait because their identity as a creative person would be activated by the decision-making process. Essentially, the choice itself may be more identity-relevant to those with higher levels of self-perceived creativity, and therefore the mindset would exert less influence on the choice between a well- versus an ill-defined problem. More formally,

H3a: A well-defined problem-solving mindset will increase consumers' choice of a well-defined task as compared to an ill-defined problem-solving mindset or no prompted mindset.

H3b: Consumers' self-perceived creativity will attenuate this effect.

STUDY 3

Design and Procedure

To test Hypothesis 3, we manipulated the type of problem-solving mindset between participants (problem-solving mindset: well-defined vs. ill-defined) and measured participants' self-perceived creativity. To insure against any sequencing effects, we counter-balanced the order of the dependent measures between participants (order: choice first vs. control measures first). This manipulation also enabled a test of the endurance of the effect because the latter condition introduced a time delay between the induction of the mindset and the task choice. The

experimental sessions were 30 minutes long and each contained groups of 5 to 20 participants. A total of 124 undergraduate students (49% male) participated in exchange for course credit.

Problem-solving mindset. We manipulated participants' problem-solving mindsets in a different manner than that used in the first two studies. Specifically, participants completed a series of four timed tasks that were each three minutes long. In the well-defined condition, each of the four tasks had a single, correct solution to encourage convergent thinking: a word search, a letter find (i.e., circle all of the 'e's in an article), a number find (i.e., circle all the '7's in a data set), and a coloring task which required participants to color in a series of shapes without going outside of the lines. In the ill-defined condition, each of the four tasks were taken from the Torrance Test of Creativity and encouraged divergent thinking. In the first task, participants saw a picture of a stuffed bunny and were asked to try to improve it by making it more fun to play with. The second task asked participants "what might be some of the things that would happen" if "people could transport themselves from place to place with just a wink of the eye?". The third task was identical to the incomplete figures task used in Study 1, and the fourth task asked participants to take a series of diamond shapes and augment them to create a story (see Web Appendix E).

Because the sets of tasks differed significantly across these two conditions, the manipulation also had the potential to influence factors other than participants' mindsets. Thus, we measured positive affect using the items used in the pre-test for Study 1 and measured self-reported effort as controls. Further, we counter-balanced the order in which these measures were presented. Half of participants responded to the questions immediately following the mindset manipulation while the other half of participants first made their choice of a subsequent task and then responded to the control measures.

We used two 2 (problem-solving mindset: well-defined vs. ill-defined) X 2 (order: choice first vs. control measures first) ANOVAs to determine whether the manipulated factors influenced either effort or positive affect. The results revealed a main effect of problem-solving mindset on both measures. Participants in the well-defined condition reported expending less effort and experiencing less positive affect than those in the ill-defined condition (Effort: $M_{\text{Well-Defined}} = 2.72$ vs. $M_{\text{Ill-Defined}} = 3.67$, $F(1, 121) = 9.39$, $p < .01$; Positive affect: $M_{\text{Well-Defined}} = 5.51$ vs. $M_{\text{Ill-Defined}} = 6.13$, $F(1, 121) = 3.59$, $p < .10$). Thus, we control for both of these measures when testing Hypothesis 3. Counter-balancing had no significant influence on either control measure.

Self-perceived creativity. On a 9-point scale, participants reported the extent to which they agreed with the following statement: “I consider myself to be a creative person.” Importantly, this measure occurred after the counter-balancing manipulation, with all participants having completed both the control measures and the choice task. The measure was mean-centered, and a 2 (problem-solving mindset: well-defined vs. ill-defined) X 2 (order: choice first vs. control measures first) ANOVA revealed that neither of the manipulated factors significantly influenced participants’ self-reported creativity (all F ’s < 1).

Dependent Measures

The focal dependent measure in this study was participants’ choice between a well-defined and an ill-defined subsequent task. Specifically, we gave participants a choice between the two Lego options used to manipulate problem-solving mindsets in Study 1. Participants were asked to, “Take a look at the two options below and think about which one you would prefer to work on. Both activities would take about 15 minutes” (see Web Appendix F). While

participants were not actually required to engage in the activity, that information was not explicitly stated prior to the choice. A pre-test was conducted to determine baseline preferences for the two Lego options. One hundred participants were recruited via mTurk in exchange for a small monetary reward. Participants were presented with the choice of either the Lego kit activity or the Lego freeform activity. One participant failed to complete the study, and of the 99 remaining participants, 39% selected the kit.

Results

Logistic regression was used to determine the independent and interactive influences of a problem-solving mindset and self-perceived creativity on participants' choice of a well-defined or ill-defined subsequent task. The model also included the control variables as well as both the main and interactive effects of the counter-balancing factor. Because the counter-balancing effects were all non-significant (all $\chi^2 < 2.8$), we collapsed over this factor.

The results reveal main effects of both a problem-solving mindset and self-perceived creativity on choice. Consistent with Hypothesis 3a, participants who had engaged in well-defined problem-solving tasks were more likely to choose the Lego kit as a subsequent activity (67%) as compared to those whose prior tasks had been ill-defined (44%) ($\beta = .45$, $\chi^2(1) = 4.75$, $p < .05$). Recall that the pre-test suggested a baseline preference for the kit of 39%, closely resembling that reported by participants in the ill-defined condition.

Self-perceived creativity had a significant, negative influence on the likelihood of choosing the kit as well ($\beta = -.31$, odds ratio (OR) = 1.36, $\chi^2(1) = 6.43$, $p = .01$). However, this individual difference exerted its influence independently of the participant's mindset, as no interaction between the two factors was observed and Hypothesis 3b was not supported. Self-

perceptions of creativity influenced choice (OR = 1.36), but they notably did not overwhelm that of the induced problem-solving mindset which had a higher effect size (inverted OR = 1.56; see Osborne 2006). Neither the influence of effort or affect was significant (affect: $\beta = .05$, $\chi^2(1) = .66$, n/s; effort: $\beta = .06$, $\chi^2(1) = .60$, n/s).

Discussion

The results from this study demonstrate that a well-defined problem-solving mindset can enhance the likelihood that a consumer will choose to engage in a subsequent well-defined problem, and it appears to do so by emphasizing the feasibility and predictability of the solution. Further, the results show that the effect of this mindset on consumers' choice is rather robust – it occurs after controlling for the effect of a chronic individual difference factor (self-perceived creativity) and endures after a delay (i.e., as demonstrated by the order manipulation).

GENERAL DISCUSSION

Over the past 25 years, there has been a proliferation of consumer products designed to meet our increasingly heterogeneous preferences, our desire for convenience, and our appetite for the latest technologies (Schwartz 2004). An over-looked benefit that many of these products provide is that of predictability – both in the process and outcome of use. Rather than using a map along with trial-and-error to find our next destination, we can now ask Siri to guide us seamlessly to that location; instead of following an Italian recipe, we can now sauté a Bertolli ready-to-cook frozen meal for dinner, and instead of struggling to retrieve an answer to a question from our memory, we can instantaneously Google the information. The marketplace essentially offers more products that engage us in well-defined problem-solving. The goal of

this paper is to better understand the downstream consequences of engaging in this type of behavior.

By considering the effects of a well-defined problem-solving mindset on both goal striving and goal setting, our studies suggest that the consequences could be significant. With their emphasis on goal striving, Studies 1 and 2 demonstrate that solving well-defined problems can diminish performance on subsequent creative tasks. Study 2 indicates that the presence of a clear goal state, rather than a known set of operators, is largely responsible for the decline. Further, this study suggests that the effects are driven, not by an individual's motivation to be creative, but by a reduction in the extent of divergent thinking in which the person engages. Study 3, then, highlights the influence of a problem-solving mindset on goal setting by demonstrating that engaging in a well-defined problem-solving exercise increases the likelihood that a consumer will choose a subsequent task that is similarly well-structured.

Theoretical Contributions and Opportunities for Future Research

Goal-Striving. In the mindset literature, the focus has primarily been on goal-striving – identifying the influence of different behavioral mindsets on *how* an individual performs in a given task. Our first two studies fall into this category and demonstrate that the cognitive procedures invoked by differently structured problem-solving tasks carry over to influence divergent thinking in subsequent tasks. To date, problem-solving has not been considered as a potential mindset, nor has creativity been considered as an outcome. Our findings demonstrate that the cognitive procedures needed to solve a well-defined initial problem, when activated, can inhibit performance on a subsequent ill-defined task.

However, it is important to note that we did not observe a similar effect when an ill-defined problem preceded one that was well-defined. As we speculated in the discussion of Study 1, this null finding may have occurred because the well-defined secondary task was not strictly well-defined since the set of operators required to solve the analogies were not clearly specified. Thus, future research is needed to understand whether the mindset invoked by solving an ill-defined problem could inhibit performance on a subsequent task that was fully well-defined as described in Table 1. More generally, since problem-solving activities lie on a continuum from well- to ill-structured, there are ample opportunities to examine problem-solving mindset effects in task pairs lying at different points along this spectrum. It is possible that the process of solving an initial problem may enhance, rather than inhibit, performance on a subsequent task if, for example, that initial task made accessible a set of relevant cognitive strategies that would ordinarily not have been prompted by the secondary task.

Goal Setting. Our third study examines consumers' goal setting and the influence that a mindset can have, not on subsequent task performance, but on a consumer's choice of the subsequent task itself. By focusing on the *why*, and not the *how*, this study is unique in the mindset literature. The study finds that a well-defined problem-solving mindset can reduce an individual's willingness to engage in a task requiring creative thought. We argue that this effect occurs because the initial task influences consumers' perceptions of both the feasibility and desirability of different possible outcomes. However, we offer no direct process evidence to support this claim, and thus, future research is needed to examine how and why a given problem-solving mindset influences the type of problem that a consumer decides to subsequently tackle.

More generally, there are substantial research opportunities in the broader mindset literature to understand how and why different mindsets influence the types of goals that

consumers choose to set for themselves. The initial task, for example, might influence the way in which consumers calculate and/or trade-off the anticipated effort and reward offered by the different subsequent tasks, and it may exert its influence either consciously or unconsciously. There are also a number of interesting moderators of these effects to examine. For example, does a person's success or failure on the initial task (whether self-perceived or objective) alter or override the type of mindset which it induced? If so, a study designed to manipulate success or failure could examine whether performance mitigates mindset carryover effects.⁵

Creativity. Our research contributes to the literature on creativity by identifying a factor that diminishes rather than enhances consumers' divergent thinking ability. While there have been a number of studies examining the conditions under which individuals think more creatively, the majority of this research identifies actions that can be taken to enhance divergent thinking. For example, firms wishing to enhance the creativity of their new product development ideas can require the use of templates (Goldenberg et al. 1999), provide training coupled with extrinsic rewards (Burroughs et al. 2011), or encourage the use of analogical thinking during the ideation process (Dahl and Moreau 2002). Few studies have identified the situational factors that influence creative performance independently of the creative task itself, and our research does so in studies 1 and 2. Identifying these conditions is important as they are likely to be far more pervasive in peoples' day-to-day lives.

Further, the majority of the studies on creativity in the marketing literature focus on either the outcomes produced during a creative task or on the process by which individuals engage in or experience the creative task. Few studies, however, examine when or why individuals choose to engage in creative tasks. In study 3, we demonstrate that both a

consumer's problem-solving mindset and their self-perceived creativity predict the likelihood that they will choose to engage in a well- or an ill-defined task.

Substantive Contributions

Our results have diverse implications for both managers and public-policy makers. For managers with oversight into their firms' new product development processes, our findings provide empirical support for the widespread belief that corporate culture influences innovative outcomes. Disney, for example, distinguishes between employees who do "routine work" (e.g., cast members at their theme parks) and those who engage in imaginative work (e.g., "imagineers" who "dream up wild ideas about new things a guest might experience") (Sutton 2001, p. 96). Routine work entails well-defined problem-solving while imaginative work requires engagement in ill-defined problem-solving. Employees rarely switch from one type of work to the others, and our findings suggest that this separation is a good one. Individual differences aside, the results from studies 1 and 2 indicate that an employee consistently engaged in routine work would produce less creative ideas than those who are not so engaged.

For managers who oversee product lines which invite co-creation with consumers, the results from study 3 have implications on the design and positioning of their offerings. Specifically, our findings suggest that managers should consider the type of problem-solving mindset that a consumer is likely to be in when either shopping for or using their products. IKEA's furniture offerings, for example, invite consumers to engage in well-defined problem-solving. When are their target consumers most likely to be receptive to such an opportunity? Our findings suggest that it is when they have recently been engaged in well-defined tasks. Thus, advertising to consumers on their drive home from work might be more effective than advertising to them on the weekend.

Products inviting consumers to self-design and self-produce products for own use such as e.g., cooking kits and on-line customization are becoming increasingly popular. In some instances, marketers may wish for the consumer to be as creative as possible when dealing with these products while in other instances the marketer may want to have as much control as possible on the end-result. Results from Study 1 and 2 suggest that when offering self-design options involving multiple stages, marketers can influence degree of creativity in the outcome products by carefully designing the structure of the tasks at the different stages in the self-design process to accommodate either a well-defined or ill-defined problem-solving mindset.

At a broader level, our research has implications for the policy makers who design the educational system and spearhead educational reforms. The growing emphasis on standardized testing influences how teachers teach and how students learn. By rewarding students, schools, and teachers for correct responses on these tests, the system encourages the assignment of well-defined problems. The results of our research suggest that such an emphasis can have an influence on both creative performance and students' proclivity to engage in activities that carry less structure.

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FOOTNOTES

1. As measured by the Torrance Test of Creativity (Torrance 1966; 1974)
2. The most downloaded TED talk to date:
http://www.ted.com/talks/ken_robinson_says_schools_kill_creativity.html
3. When gender was included as a covariate in the analyses in the paper, it had no significant effect on the dependent measures. The results are consistent regardless of its presence in the model.
4. The correlations among the constructs were .34 (originality / elaboration), .33 (originality / abstractness), and .56 (elaboration / abstractness).
5. We thank two of our anonymous reviewers for these suggestions.

Table 1

ILL-DEFINED VERSUS WELL-DEFINED PROBLEM SPACES

| <i>Part of the Problem Space</i> | <i>Ill-defined</i> | <i>Well-defined</i> |
|----------------------------------|---|--|
| Initial State | Ambiguous and open to interpretation | Clearly specified and unambiguous |
| Set of Operators | Unclear and/or unspecified, requiring exploration and experimentation (divergent thinking) | Known and/or specified, emphasizing speed and accuracy (convergent thinking) |
| Goal State | Achieved by evaluating and selecting a solution from the generated candidates (no clear stopping point) | Achieved by reaching a correct answer (a clear stopping point) |

Table 2
STUDY 1: PRETEST RESULTS

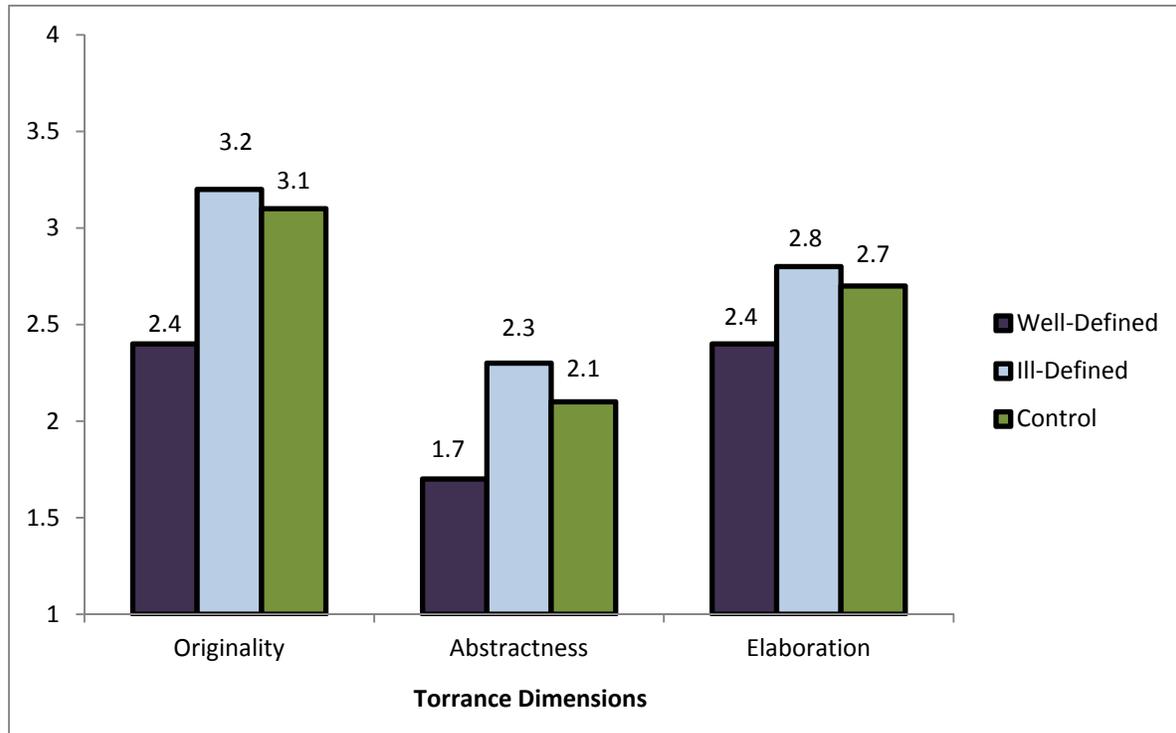
| <i>Initial Task</i> | <i>Depletion: Number of Correct Anagrams</i> | <i>Negative Affect (1- 9 scales)</i> | <i>Positive Affect (1 – 9 scales)</i> | <i>Tolerance for Ambiguity (1 – 5 scales)</i> | <i>Sense of Accomplishment (1 – 9 scales)</i> |
|---------------------|--|--|---|---|---|
| Well- Defined | 7.39 (2.88) | 2.80 (1.74) | 5.69 (1.51) | 2.31 (.62) | 5.59 (1.69) |
| Ill-Defined | 6.11 (3.19) | 2.81 (1.38) | 5.73 (1.40) | 2.29 (.56) | 5.15 (2.14) |
| Control | 6.10 (2.77) | 2.84 (1.59) | 5.24 (1.41) | 2.60 (.77) | n/a |

Table 3

STUDY 2: THE PRESENCE OF A CORRECT OUTCOME IN TASK 1
DECREASES CREATIVE PERFORMANCE IN TASK 2

| | <i>Instructions Present</i> | | | | | | <i>Instructions Absent</i> | | | | | |
|--------------------|-----------------------------|--------|-------------|--------|-----------|--------|----------------------------|--------|-------------|--------|-----------|--------|
| | Fluency | | Originality | | Enjoyment | | Fluency | | Originality | | Enjoyment | |
| Outcome Present | 5.59 | (1.96) | 1.21 | (1.27) | 7.37 | (1.43) | 5.29 | (2.39) | 1.32 | (1.79) | 5.48 | (2.06) |
| No Outcome Present | 6.38 | (2.86) | 1.97 | (2.48) | 7.40 | (1.15) | 5.44 | (1.96) | 2.15 | (2.11) | 7.04 | (1.31) |

FIGURE 1
STUDY 1: THE INFLUENCE OF PROBLEM-SOLVING MINDSETS ON TORRANCE TEST
PERFORMANCE



WEB APPENDIX

The Downstream Consequences of Problem-Solving Mindsets: How Playing with Legos Influences Creativity

C. Page Moreau and Marit Gundersen Engeset

Web Appendix A

THE LEGO KIT



Web Appendix B

ANAGRAM TASK

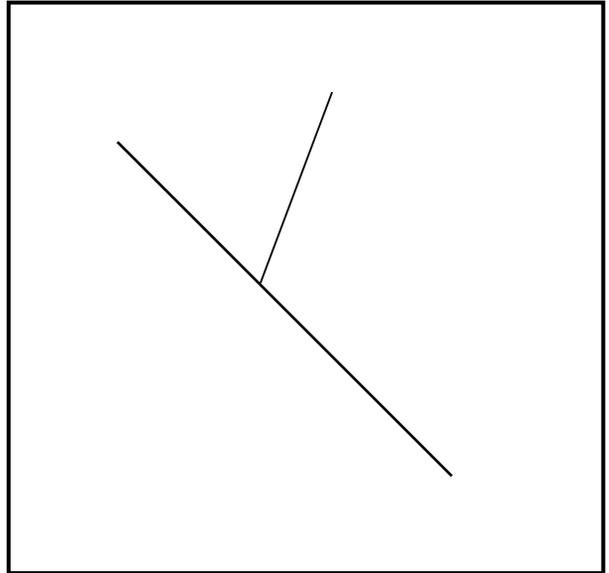
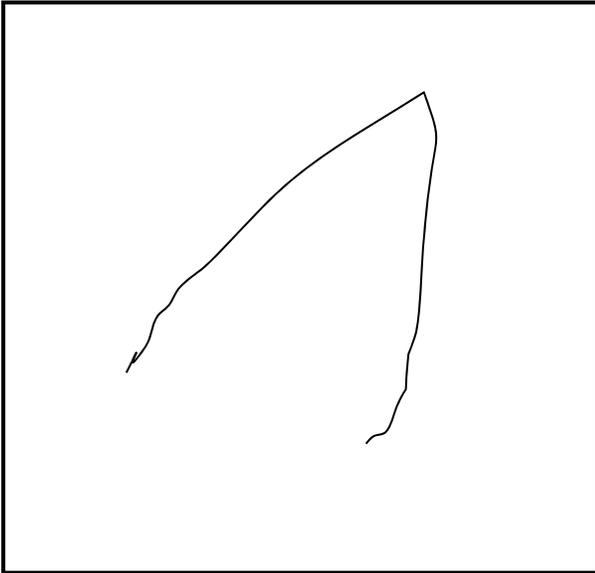
Anagram Task

For each of the words below, rearrange the letters to form another word in English. For example, the word "early" can be transformed into the word "layer."

- 1) Drier _____
- 2) Flesh _____
- 3) Defer _____
- 4) Toned _____
- 5) Tacit _____
- 6) There _____
- 7) Omits _____
- 8) Night _____
- 9) Ruled _____
- 10) Satin _____
- 11) Silence _____
- 12) Spots _____
- 13) Praised _____
- 14) Tough _____
- 15) Dashed _____
- 16) Artist _____
- 17) Ideals _____
- 18) Marines _____
- 19) Danger _____
- 20) Endive _____
- 21) Terrain _____
- 22) Traipse _____
- 23) Saltier _____
- 24) Parsley _____
- 25) Trout _____

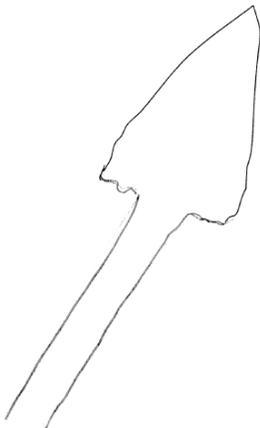
Web Appendix C

STUDIES 1 AND 3: THE INCOMPLETE FIGURES TASK



EXAMPLES OF COMPLETED FIGURES:

TITLE: Spear



TITLE: Restrictions



Web Appendix D

STUDY 1: SAMPLE QUESTIONS FROM THE MILLER ANALOGY TEST

- 1) War is to destruction as germ is to:
 - a. Influenza
 - b. Warfare
 - c. Disease
 - d. Dirt

- 2) Comrade is to friend as recollect is to:
 - a. Memoirs
 - b. Remember
 - c. Memory
 - d. Enemy

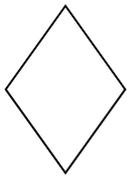
- 3) Arrival is to departure as invasion is to:
 - a. Evacuation
 - b. Approach
 - c. War
 - d. Reception

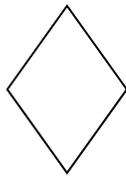
- 4) Control is to order as anarchy is to:
 - a. Chaos
 - b. Discipline
 - c. Power
 - d. Government

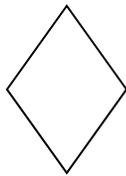
- 5) Law is to citizen as constitution is to:
 - a. Rights
 - b. Democracy
 - c. Regulation
 - d. Government

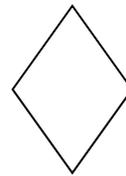
Web Appendix E*STUDY 3: A TASK IN THE ILL-DEFINED PROBLEM-SOLVING CONDITION*

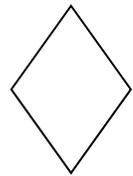
Add details to the shapes below to make pictures out of them. Make the diamond a part of any picture you make. Try to think of pictures no one else will think of. Add details to tell complete stories with your pictures. Give your pictures titles. You have 4 minutes.

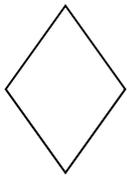


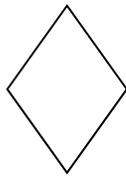


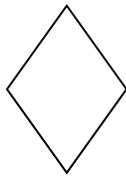


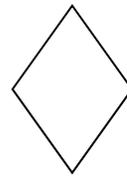


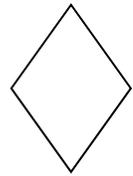












Web Appendix F

STUDY 3: CHOICE MEASURE

Take a look at the two options below and think about which one you would prefer to work on. Both activities would take about 15 minutes.

Option 1

Put together a Lego kit like the one shown below. There are step-by-step instructions for you to follow that will help you put the product together.



Option 2

Put together something (or things) of your own choosing by playing with a box full of Legos like the one shown below.

