JOURNAL OF MANAGEMENT ACCOUNTING RESEARCH
Vol. 32, No. 1
Spring 2020
pp. 159–176

American Accounting Association
DOI: 10.2308/jmar-52479

# Performance Incentives, Divergent Thinking Training, and Creative Problem Solving

**Kun Huo**
*Western University*

**ABSTRACT:** Creativity theory suggests that effective solutions to creative problems depend on both divergent and convergent thinking (Cropley 2006). Using an experiment in which participants solve insight problems, I investigate the effect of incentive schemes on creative problem-solving performance. I find that both piece-rate pay and a flat wage plus public recognition generate higher performance with divergent thinking training than without. Consistent with the idea that incentives may promote more convergent thinking than divergent thinking, piece-rate pay generates lower creative problem-solving performance than the flat wage in the absence of divergent thinking training (flat wage plus recognition has a neutral effect). The study suggests that when employee performance depends on creative problem solving, firms should implement incentive schemes and/or control systems that promote both divergent and convergent thinking.

**Keywords:** creative problem solving; piece-rate pay; public recognition; divergent thinking training.

## I. INTRODUCTION

Although organizations benefit significantly when employees take creative approaches to solve difficult problems, the methods organizations use to motivate employees to be creative can be quite varied. For example, Toyota Motor Corporation encourages new ideas from its shop floor employees and pays them a percentage of the cost savings generated from the implemented ideas (Miller 2007). In the U.K. Department for Work and Pensions, process-improvement ideas generated by employees in an internal forum are awarded points, which can be redeemed for tangible rewards; in addition, a leaderboard of top point earners is made public to the organization (Vezina 2011). The University of British Columbia (UBC 2018) library uses an annual innovation award to recognize employees for "demonstrating new ways of performing existing processes, or undertaking work that supports the vision of the Library's Strategic Plan." In a survey conducted by Burroughs, Dahl, Moreau, Chattopadhyay, and Gorn (2011), 20 companies of various sizes and industries exhibited very different approaches to incentivizing creativity and innovation, ranging from not providing any additional rewards, to monetary bonuses, to token rewards and public recognition opportunities.

In academia, there is little consensus on how to improve creative problem-solving performance via incentives or other means (Bonner, Hastie, Sprinkle, and Young 2000; Beckers, Cools, and Van Den Abbeele 2010). In particular, the link between monetary incentives and performance is mixed (Bonner et al. 2000; Kachelmeier, Reichert, and Williamson 2008; Webb, Williamson, and Zhang 2013). Similarly, while ample anecdotal evidence suggests that public recognition is used to encourage more creative problem solving (Nicholson 1998), research evidence is limited to clerical and learning tasks (Kosfeld and Neckermann 2011; Ashraf, Bandiera, and Lee 2014). To make an advance from prior experimental studies that tend to examine the effect of incentives on creative problem solving in isolation, this current experimental study considers the

This paper is based on my dissertation completed at the University of Waterloo. Thanks to Khim Kelly and Theresa Libby (co-chairs) for their guidance. The manuscript improved significantly from comments by Gary Hecht (editor) and two anonymous reviewers. I am grateful to Anthony McCaffrey for providing materials and data from his thesis. Further thanks to Abigail Scholer, Alan Webb, Brad Pomeroy, Christoph Feichter, David Sharp, Eddy Cardinaels, Gregory McPhee, Ivo Tafkov, Jeremy Douthit, Johnny Jermias, Joseph Burke, Lan Guo, Leslie Berger, Matt Sooy, Michael Williamson, Steve Kaplan, Tim Mitchell, Weiming Liu, as well as seminar participants at Monash University, the University of Calgary, the University of Guelph, the University of Waterloo, Western University, the 2016 CAAA Annual Conference, the 2016 AAA Annual Meeting, the 2016 MAS Section Meeting, and the 2016 ABO Section Meeting. I also benefited from research assistance by Andrea Stapleton and Kaleab Mamo. Financial support from the University of Waterloo and Western University helped me complete this study.

Supplemental materials can be accessed by clicking the link in Appendix A.

Kun Huo, Western University, Ivey Business School, London, Ontario, Canada.

Editor's note: Accepted by Gary Hecht, under the Senior Editorship of Karen L. Sedatole.

*Submitted: November 2016*
*Accepted: April 2019*
*Published Online: July 2019*

effectiveness of organizations offering a combination of performance incentives, monetary or otherwise, and creativity training programs (Bonner and Sprinkle 2002; Chrysikou 2006).

Cropley's (2006) theory provides support for providing both a performance incentive and creativity training in order to increase creative problem-solving performance. Cropley (2006) suggests that creative performance is driven by a combination of divergent thinking (i.e., being unconventional and producing multiple answers) when generating new ideas, and convergent thinking (i.e., being logical and seeking the single best answer) when validating ideas against problem constraints.[1] Extant research suggests that incentives increase convergent thinking by motivating individuals to re-apply set techniques, play it safe, and stick to a narrow range of obviously relevant information (Weisberg and Suls 1973; Ederer and Manso 2013). In comparison, incentives generally do not increase, and may even crowd out, divergent thinking (Amabile 1996; Cropley 2006; Kilgour and Koslow 2009). However, research demonstrates that a person's divergent thinking skills can be improved through training (Ansburg and Dominowski 2000; Dow and Mayer 2004; Plumlee, Rixom, and Rosman 2015). In particular, Plumlee et al. (2015) find that auditors perform best when they receive both divergent and convergent thinking training. These results, which are consistent with Cropley's (2006) model, indicate that while divergent thinking is helpful, it must be supplemented with convergent thinking to increase performance.

I study two types of incentives—piece-rate pay and public recognition—and compare them against a fixed wage contract. Piece-rate pay can generate greater motivation for individuals to seek a solution to the creative problem presented to them than a flat wage. However, piece-rate pay may also motivate individuals to focus on one particular solution and prevent them from finding the best solution, which often requires attention to a less dominant piece of information in the problem space (Weisberg and Suls 1973; Ederer and Manso 2013). The inability to look beyond the conventional is also known as functional fixation (Glucksberg 1962). In other words, the piece-rate pay incentive may cause individuals' convergent thinking to outweigh their divergent thinking during the idea-generating phase, leading to a shortage of potential solutions to test against stated constraints.

Divergent thinking training may mitigate the above problem. Training potentially overcomes this problem by prompting individuals to consider unconventional uses of scenario objects (McCaffrey 2012). Thus, individuals can avoid functional fixation and generate a greater number of potential solutions, increasing the chance that the best solution can be found among the solutions generated. Therefore, I predict that piece-rate pay in the presence of divergent thinking training leads to higher creative problem-solving performance than piece-rate pay alone.

Like piece-rate pay, public recognition can also motivate individuals' performance (Wang 2017). However, its effects on divergent thinking—absent related training—are less understood. On one hand, public recognition makes relative performance more salient, which can increase risk taking (Ashton 1990; Dewett 2007), which can in turn induce divergent thinking. At the same time, public recognition can induce social comparison, which can increase effort but also cause fixation and activate convergent thinking at inopportune creativity phases similar to piece-rate pay. I expect that divergent thinking training will enhance the effect of public recognition. Specifically, divergent thinking training complements the motivational effects of public recognition, as training will help individuals generate more ideas (relative to receiving flat wages alone), and help convert the additional effort from social comparison into more beneficial convergent thinking by enabling individuals to select the best generated idea.

In an experiment, I manipulate both incentive type and the presence of divergent thinking training. Experiment participants are assigned one of three incentive schemes: flat wage, piece-rate pay, or flat wage plus public recognition. The public recognition incentive that is added to flat wage is operationalized as an email sent to everyone assigned to that condition announcing the top performers' names, academic program, and performance. The flat wage alone and flat wage plus public recognition conditions receive the same amount of money. In contrast, those receiving piece-rate pay have a smaller fixed wage component and earn bonuses commensurate with performance. To operationalize creative problem solving, I require participants to solve a set of insight problems that vary in level of difficulty (Duncker 1945). Insight problems demand creative problem solving because their best solutions require the problem solver to think about conventional objects and concepts differently (Chu and Macgregor 2011). These problems allow me to test Cropley's (2006) theory that individuals must exercise divergent thinking in the idea-generation phase of the creative process, and then exercise convergent thinking when verifying the ideas against problem constraints that outline what is practical.[2] Creative solutions that are practical are far more valuable to

[1] Cropley (2006) breaks down the creative process into seven phases: information acquisition, preparation, incubation, illumination, verification, communication, and validation. As a person progresses through these stages, the pertinent task changes from collecting key information about the problem and generating potential solutions to selecting the most promising solution and getting external confirmation from judges. An important part of Cropley's (2006) model is that convergent and divergent thinking skills are needed in different amounts across different phases. As a result, individuals may have difficulty properly shifting effort between divergent to convergent thinking, or *vice versa*.

[2] The creative task most familiar to accounting researchers is the Rebus puzzle task described in Kachelmeier et al. (2008). This task differs from the insight problem used here in that the Rebus puzzle task poses no clear constraints. The lack of clear constraints reduces the need for convergent thinking by the problem solver. In contrast, many creative problem-solving tasks have clear constraints such as budget, personnel, technology, and market conditions. For example, the Apple iPod was a novel idea that allowed customers to hold "1,000 songs in your pocket" for a premium price; yet the idea was "pie in the sky" until Apple Inc. overcame limitations on storage capacity by sourcing Toshiba Corporation's mini hard drive (Kahney 2006).

a firm than those that are not (Kilgour and Koslow 2009). Hence, I examine a setting in which both novelty and practical constraints must be considered when evaluating the quality of the solutions.

The results of this study are consistent with my predictions. I find that, in the flat wage/no training condition, individuals are better at creative problem solving than those in the piece-rate pay/no training condition. In contrast, individuals in the flat wage/no training condition are no better at creative problem solving than those in the flat wage plus public recognition/no training condition. I also find a positive interaction between piece-rate pay and divergent thinking training and between public recognition and divergent thinking training on performance. Further, these positive interactions are consistent across easy and difficult insight problems.

This study contributes to research and practice in the following ways. First, I leverage Cropley's (2006) theory to provide an explanation as to why incentives may or may not increase performance on a creative problem-solving task. Using both piece-rate pay and a flat wage plus public recognition as incentives and contrasting them with only a flat wage, I show that incentives alone may not increase performance when divergent thinking training is not provided. In fact, piece-rate pay reduces performance relative to the flat wage condition, while a flat wage plus public recognition has no significant effect on performance relative to the flat wage condition. Positive effects for (1) piece-rate pay relative to the flat wage condition, and (2) the flat wage plus public recognition relative to the flat wage condition are found only when divergent thinking training is provided. The implications for practice are that firms should consider supplementing incentives with divergent thinking training when they want employees to generate creative solutions to difficult problems or firms should provide incentives to only those who already demonstrate sufficient divergent thinking ability.

Another contribution of my research is the introduction of insight tasks to the study of incentives and creativity. Prior research by Kachelmeier et al. (2008) and Kachelmeier and Williamson (2010) finds that incentives do not change creative performance on divergent thinking tasks. My study replicates this finding using insight tasks, but also demonstrates that incentives can be beneficial in combination with divergent thinking training. However, the task in my study and the Rebus puzzle task in Kachelmeier et al. (2008) have a key difference. The Rebus puzzle generation task has only vague solution constraints, whereas the insight task I use has more clearly defined constraints and, as result, benefits from a higher level of convergent thinking. Therefore, my study also shows that future studies about incentive effects on creativity need to consider task differences.

The remainder of this paper is organized into four sections: development of the hypotheses in Section II, an explanation of the experimental design in Section III, presentation of the results in Section IV, and a summary and discussion of those results in Section V.

## II. BACKGROUND AND HYPOTHESES

### Divergent Thinking, Convergent Thinking, and Creative Problem Solving

I use Cropley's (2006) model of creativity to examine the role of incentives in individual creative problem solving. Cropley (2006) argues that individuals must use both convergent and divergent thinking to generate both novel and useful solutions. More importantly, he asserts that different levels of divergent and convergent thinking are needed in different phases of creativity. The seven phases—information, preparation, incubation, illumination, verification, communication, and validation[3]—describe the process through which a problem is conceived to the point when the solution is presented and evaluated by others.[4] Although prior literature has typically associated creativity with divergent thinking because the idea-generation phases (i.e., incubation and illumination) require it, Cropley (2006) argues that creativity also requires convergent thinking because it contributes to success during the idea-verification and communication phases. Proper verification can reduce the risk of organizations introducing reckless and disastrous changes that lead to loss. In other words, convergent thinking can help to rein in "pie-in-the-sky" thinking (Grabner 2014).

In Cropley's (2006) model, divergent and convergent thinking are defined as two separate meta-cognitive processes. Divergent thinking is associated with "being unconventional, seeing the known in a new light, combining the disparate, shifting perspectives, and producing multiple answers," whereas convergent thinking is associated with "being logical, recognizing the familiar, re-applying set techniques, and homing in on the single best answer" (Cropley 2006, 392).[5] Cropley's (2006) model can be used to achieve a better understanding of prior findings on incentives and creativity; in

---

[3] These seven steps are an expansion of Wallas's (1926) classical phase model, which has four steps: preparation, incubation, illumination, and verification.

[4] Cropley (2006) is not the only one to suggest a multi-phase model of creativity (see Amabile 1996); however, his seven-phase model is unique because it also includes theory about divergent and convergent thinking.

[5] Past research has defined creativity as an outcome involving both novelty and appropriateness, but these two supposedly independent constructs have proven to be negatively correlated (Amabile 1996; Runco and Charles 1993; Rietzschel, Nijstad, and Stroebe 2010). In Cropley's (2006) model, divergent and convergent thinking are inputs rather than outcomes. Thus, the literature can be advanced through the study of the effects of external forces on these two cognitive processes.

particular, the requirement for varying levels of divergent and convergent thinking in different creativity phases helps explain why incentives can sometimes fail to raise the level of creative performance (cf. Kachelmeier et al. 2008; Kachelmeier and Williamson 2010). It is important to note that existing models of creativity posit that divergent thinking is the result of knowledge, creative thinking skills, and intrinsic motivation rather than extrinsic motivation (Amabile 1996; Weisberg 2006). Given that the Rebus puzzle generation task used by Kachelmeier et al. (2008) focused more on the incubation and illumination phases (which require mainly divergent thinking), it may not be surprising that performance was more difficult to incentivize. However, many creative solutions also require convergent thinking, especially when individuals are required to verify and communicate their own ideas. For example, Chen, Williamson, and Zhou (2012) provide evidence about the importance of convergent thinking to creative problem-solving performance. In their study, teams receiving a group incentive generated more creative solutions than teams receiving individual incentives. Chen et al. (2012) show that group incentives generate higher group cohesion and encourage individuals to build on others' ideas. The processes of elaboration, making logical extensions, and selecting the best idea are consistent with the definition of convergent thinking.[6]

### Incentives and Constraint Clarity

The degree of constraint clarity is an important factor that, together with the Cropley's (2006) seven-phase model, contributes to our understanding of how incentives affect performance during the creative process. In business, creative problems display a range of constraint clarity. For example, an aid agency requests a solution for transporting a vaccine in rural Africa where roads are poor, conditions are hot, and budgets are tight. This is an example of a problem with high constraint clarity, as these constraints limit the types of submissions the organization will accept. In a different example, a rugby league requests ideas to help it make use of the data it has collected on its players and games. This is an example of a problem with low constraint clarity as no constraints are explicitly stated.[7] The clarity of the constraint(s) in the problem definition affects the need for convergent thinking during the verification and communication phases. The clearer the constraints, the more mindful individuals should be when exploring potential solutions. It follows that incentives that encourage convergent thinking for problems with clearly defined constraints will increase creative performance during verification and communication.[8]

Reflecting the diversity of problems in real life, research on creativity has generated a plethora of ways to measure creativity, leading to a range of conflicting results. In Figure 1, I place the experimental tasks in the accounting literature on a continuum from high to low constraint clarity, which correlates with the need for convergent thinking. On the lower end, the Rebus puzzle generation task used by Kachelmeier et al. (2008, 343) appears vague as the task is to generate "puzzles that are original ideas, innovative, and clever." Similarly, the unusual-uses task in de Vericourt, Hales, Hilary, and Samet (2017) asks for creative uses of a barrel without further constraints. Toward the middle, the abandoned-house task used by Chen et al. (2012, 1892) asks for a solution that "is original, innovative, and implementable within a reasonable budget." The budget constraint, although not precisely quantified, limits the discussion of the more fanciful but highly expensive ideas. On the higher end, the remote associates test (or RAT) used by Bailey, Fessler, and Laird (2015) and McPhee (2017) has strict constraints.[9] Results from these studies generally conform to the theory that as the need for convergent thinking increases, the positive impact of incentives on performance also increases.[10]

---

[6] Recent psychology research shows that convergent thinking, which is measured as performance on Raven's progressive matrices—a perceptual logical test—is a stronger determinant of creative performance than divergent thinking, which is measured as a degree of schizotypy (Webb, Little, Cropper, and Roze 2017). Webb et al. (2017) used lateral thinking problems to measure creativity, and these problems imposed tighter solution constraints than the insight problems used in my study. Their study is a further illustration that different creative tasks may require different levels of convergent and divergent thinking, as predicted by Cropley's (2006) theory.

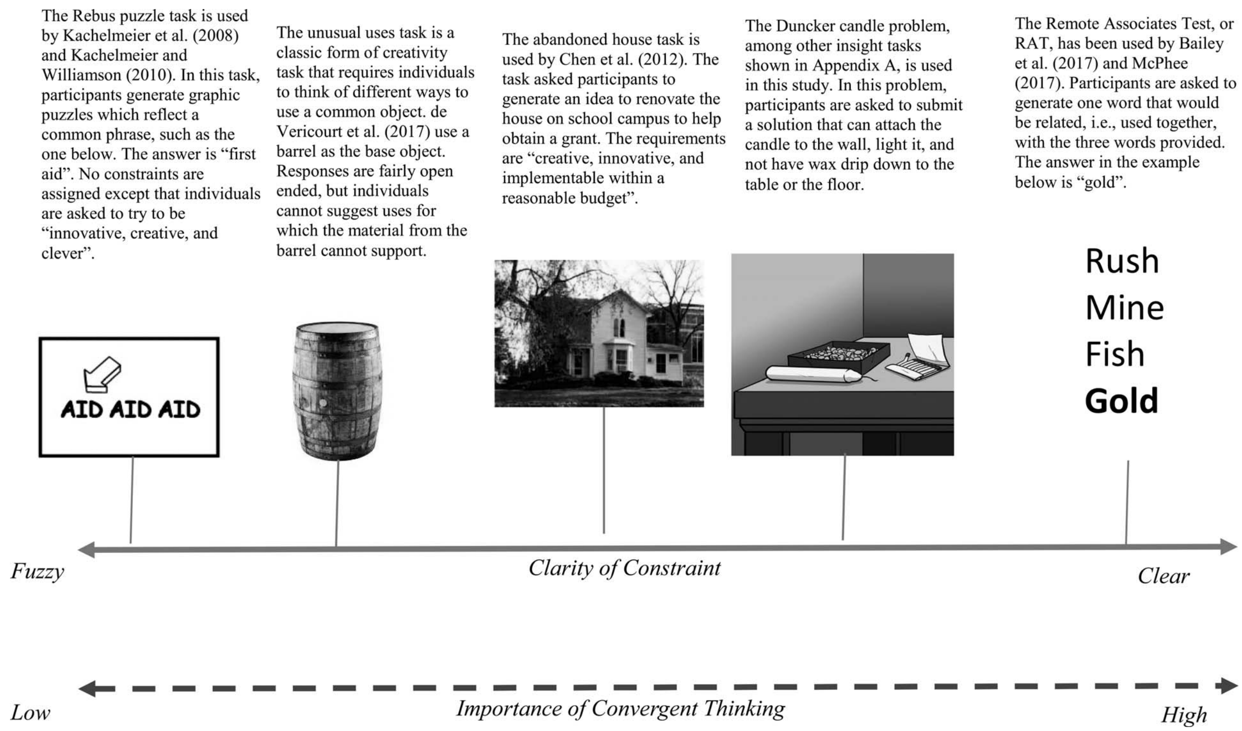
[7] These are real examples found at https://www.innocentive.com/, a website that helps to connect requestors with solvers in the "crowd." Usually, a monetary prize is awarded for the winning solution.

[8] Problems with vague constraints also need convergent thinking. In such problems, however, the responsibility for converging is passed to the evaluators, who apply their existing knowledge to determine the best answer(s). For example, in his discussion of Kachelmeier et al. (2008), Sprinkle (2008) points out that the participants do not have a good idea of what the evaluators want and, as a result, participants may not properly allocate their efforts during the Rebus puzzle creation task. Applying Cropley's (2006) model, I expect that if the criteria of evaluation were given, participants would be able to think in a more convergent manner and discard less creative ideas. Herein lies the inherent tension in creative problem solving: often, even the evaluators do not know what they want until a group of solutions has been presented. If evaluators knew what they wanted, they would define the constraints more clearly to avoid waste of human resources.

[9] Usually, there is only one word in the vocabulary that can be simultaneously related to the three given in these puzzles. See Figure 1 for examples.

[10] Some research in the psychology literature also studies how rewards affect creativity, although not with performance-based incentives as a primary focus. Some studies find that when promised a reward, individuals exhibit lower creativity in their responses to the problem compared to no reward (e.g., Amabile, Hennessey, and Grossman 1986); however, other studies find that if the individuals are given hints about what creative solutions look like, rewards are beneficial to creativity (e.g., Eisenberger and Armeli 1997). The outcome ultimately depends on the type of creative problem.

**FIGURE 1**
**Conceptual Map of Current Creativity Tasks in the Experimental Management Accounting Studies**




## Insight Problems and Functional Fixation

In this study, I examine insight problems that have a moderate to high level of constraint clarity; individuals must work with the only materials given to develop an effective solution to difficult problems. Wedell-Wedellsborg (2017) recounts the example of a landlord who faced complaints from tenants because the elevator was slow. Rather than speed up the elevator or install a new one, both of which would have been very costly, the landlord mounted mirrors and put music in the elevator. There were no more complaints as the tenants were occupied while they waited for the elevator to reach their floor. This example demonstrates the need to look beyond an obvious but costly solution by restructuring a problem and exploring different solution spaces. Another example of insight may be found in software engineering, a field in which firms depend on their workers' ability to overcome problems with elegant coding.

Insight problems used in prior creativity research resemble the elevator problem. In these problems, although some constraints are present, it is often hard for individuals to decide whether the best solution has been found because each solution has a different level of effectiveness. Because insight problems usually have a moderate to high level of constraint clarity, the need for convergent thinking is also moderate to high. To demonstrate, in the candle problem (see Figure 1), individuals are given a candle, a book of matches, and a box of thumbtacks, and must figure out a way to suspend the candle from the wall so that the wax does not drip onto the table below. One potential solution is to use thumb tacks and matches to suspend the candle from the wall, but given these materials, the process will be complicated and the final structure flimsy. If individuals decide to stop searching after identifying one option, they could convince themselves that the problem is solved. However, if they decide to continue the search for new configurations, they may realize that the best way to suspend the candle is to empty the box holding the thumbtacks, tack the box to the wall, and then place the candle in the box.

On the one hand, given the level of constraint clarity in insight problems like the candle problem, configuring a solution that fits requires convergent thinking. On the other hand, coming to a conclusion too quickly can prevent sufficient divergent thinking and limit the number of potential solutions generated. In this way, insight problems demand divergent thinking to overcome functional fixation (Chrysikou 2006). Functional fixation occurs when individuals are unable to adapt to the demands of the current situation because of existing knowledge structures. Fixation is a frequent problem in design, engineering, and even decision making using accounting information (McCaffrey and Krishnamurty 2014; Libby, Bloomfield, and Nelson 2002).

Some evidence of functional fixation is also present in Webb et al.'s (2013) research, which finds that incentivized individuals are less effective at locating efficiencies in the production process than those who do not receive an incentive. Webb et al. (2013) attribute this effect to cognitive overload, suggesting that the pressure from high-powered incentives reduces the amount of cognition required for identifying complex patterns. An alternative, and complementary, way to interpret these results is that individuals who received high-powered incentives only focus on incremental changes and, as a result, fail to discover additional "shortcuts" because they do not recognize divergent patterns. Clearly, overcoming functional fixation is important to many different types of creative problem solving.

## Development of Hypotheses and Research Questions

### *The Effect of Piece-Rate Pay*

Many firms use piece-rate pay, a common form of monetary incentive, to direct employee attention and increase employee effort (Bonner and Sprinkle 2002). A performance bonus tied to the number of problems solved will increase the amount of effort the employees spend on the problems assigned. However, incentives may also cause employees to focus on the wrong performance driver when the path to the solution is less clear. Ederer and Manso (2013) show that piece-rate pay encourages individuals to make more incremental changes than radical changes in an innovation task that requires radical changes and experimentation. Using the candle problem, Weisberg and Suls (1973) find that incentives encourage individuals to produce many variations of one type of solution rather than to explore conceptually different ideas. These findings demonstrate that incentivizing individuals to submit a correct solution triggers the convergent mindset of "playing it safe" and "sticking to a narrow range of obviously relevant information" described by Cropley (2006). Convergent thinking can be beneficial on a task that does not require divergent thinking. For example, Awasthi and Pratt (1990) find that incentives are associated with accuracy and knowledge reapplication, leading to higher performance on statistical and economic decision making. Higher performance on Awasthi and Pratt's (1990) task requires people to be logical and recognize the familiar—skills that characterize convergent thinking.

Creative problem-solving tasks, such as insight problems, require individuals to apply divergent thinking to generate new solutions (incubation and illumination) and to apply convergent thinking to narrow down the options and arrive at the best solution (verification).[11] Moreover, to generate the best solution, individuals must use divergent thinking to overcome functional fixation. Piece-rate pay has been shown to lead to a more cautious and incremental approach. In a time-constrained setting, this approach leads to fewer generated solutions. In addition, individuals are less likely to overcome functional fixation because incentives encourage them to start with the familiar rather than the unfamiliar. Thus, in the absence of divergent thinking training, I predict that individuals working for piece-rate pay will have lower creative problem-solving performance than those working for flat wages.

**H1:** In the absence of divergent thinking training, piece-rate pay will reduce creative problem-solving performance, compared to a flat wage.

## The Effect of Public Recognition

Public recognition may be more appropriate than piece-rate pay in organizations that depend on creative problem solving. Piece-rate pay, as well as other monetary incentives, can be difficult to apply for two reasons: (1) insight and creativity are only intermediate processes, and (2) potential profits may not be realized until the distant future. Therefore, rather than introducing piece-rate pay that has tenuous links to actual profits, the firm may use nonmonetary incentives like public recognition to motivate creative performance. As described in psychology literature, the desire for public recognition is related to the human need for self-esteem (Alderfer 1972; McClelland 1967). Festinger's (1954) social comparison theory explains that individuals gain esteem when their abilities and accomplishments exceed those of their peers. If public recognition is given on a relative basis, high-performing individuals are differentiated from their peers. As a result, individuals work harder than they normally would when offered the chance to be recognized. Laboratory and field studies in both accounting and economics have supported the use of public recognition to increase employee effort and performance (Kosfeld and Neckermann 2011; Lourenço 2016; Tafkov 2013; Wang 2017).

In addition to increasing effort, public recognition of relative performance may better facilitate divergent thinking through risk taking. In a tournament setting, Hannan, Krishnan, and Newman (2008) find that tournament incentives encourage individuals to pursue risky strategies in a probability learning task. Ashton (1990) finds that tournament incentives increase risk

[11] Cropley (2006) suggests that effort and knowledge are important for successful convergent thinking. This study focuses on incentives' effects on effort rather than knowledge.

taking in the form of more extreme ratings in a bond risk assessment task. Dewett (2007) shows that divergent thinking and risk taking are positively correlated, but the causal direction has not been established.

In summary, theory suggests that public recognition can increase effort. As with piece-rate pay, the increase in effort caused by public recognition may, in turn, increase convergent thinking and reduce divergent thinking during idea generation, ultimately leading to lower performance. As argued earlier, individuals may fail to solve insight problems because they focus too much on convergent thinking, incentive induced or otherwise. Yet, because public recognition uses relative performance to motivate individuals, it may also increase risk taking and divergent thinking. As there has been little research on the effect of nonmonetary incentives and risk taking, or on the effect of risk taking and divergent thinking, I pose a research question rather than a hypothesis.

**RQ1:** In the absence of divergent thinking training and under a flat wage, will public recognition generate lower creative problem-solving performance (relative to no public recognition)?

### *The Effect of Performance Incentives and Divergent Thinking Training*

Although I hypothesize that piece-rate pay will lead to lower creative problem-solving performance than a flat wage will, I do not argue that firms looking to increase performance should eliminate piece-rate pay. Even though piece-rate pay incentives motivate individuals to apply familiar knowledge structures (thus reducing the number of ideas generated and perpetuating functional fixation), they also motivate individuals to be logical and consistent and to ensure that the ideas generated satisfy the problem constraints. The correct complement to this process is not to ask individuals to give up convergent thinking; rather, individuals must be directed to access the less familiar parts of their knowledge by applying divergent thinking.

For example, McCaffrey (2012) instructs individuals to think about objects in terms of their basic parts, and avoid describing them with words associated with their default uses. The benefit of such training is to prompt individuals to reduce their focus on the standard solution (the source of fixation) and to branch out to other possibilities.[12] McCaffrey's (2012) technique has a synergistic effect with convergent thinking because the technique requires a logical extension of individuals' existing knowledge structures. Once a larger group of new ideas is generated, incentive-induced convergent thinking increases performance during the verification stage by checking the potential solutions against the constraints introduced in the problem, filtering out imaginative but impractical ideas. For the above reasons, I expect piece-rate pay and a flat wage plus public recognition will interact with divergent thinking training. Specifically, both will have greater performance with divergent thinking training than without divergent thinking training. I make the following formal predictions:

**H2a:** The difference in performance levels between piece-rate pay versus a flat wage will be greater in the presence of divergent thinking training than it will in the absence of divergent thinking training.

**H2b:** The difference between performance levels with a flat wage plus public recognition versus a flat wage alone will be greater in the presence of divergent thinking training than it will in the absence of divergent thinking training.

The interactions predicted in H2a and H2b are not without tension. The predictions do not simply reflect what Bonner and Sprinkle (2002) describe as the positive interaction between monetary incentives and individual skill. Bonner and Sprinkle (2002) predict that skill can increase effort-to-performance sensitivity because more skilled individuals find complex tasks easier to perform than less skilled individuals. Accordingly, monetary incentives have a stronger motivational effect than nonmonetary ones because when workers are more skilled, incentives are more attainable. It is important to note that Bonner and Sprinkle (2002, 319) define complexity as "the amount of attention or processing a task requires as well as the amount of structure and clarity the task provides." In other words, task complexity increases as the amount of information processing increases. Divergent thinking training, such as that used in McCaffrey (2012), teaches people to break down objects to components, leaving individuals with more information to process and more options to evaluate, but individuals still must narrow down the list of options on their own. Hence, it could be argued that divergent thinking training makes the task more, rather than less, complex. If the task becomes more complex because of applying divergent thinking training, it is no longer obvious that the combination of incentives and McCaffrey's (2012) divergent thinking training should always improve performance.

[12] A long line of psychology research shows that training programs that provide divergent thinking skills through instruction, practice, and performance feedback can yield positive results (Ansburg and Dominowski 2000; Chrysikou 2006; Dow and Mayer 2004; McCaffrey 2012). Creativity training has been used previously in the audit setting. Plumlee et al. (2015) devise a creative problem-solving training program to improve the effectiveness of analytical procedures. They find that auditors who receive partial training (divergent thinking alone) and full training (a combination of divergent and convergent thinking) generate more explanations for the results of analytical procedures than auditors who receive no training. Moreover, Plumlee et al. (2015) find that only those receiving full training generate a set of explanations that contain the actual reasons behind the identified variances.

## III. METHOD

### Participants

I recruited 120 undergraduate student volunteers from a large Canadian public university. These students participated in one of 12 60-minute experimental sessions, with five to 15 participants per session. As the participants arrived, they were randomly assigned to separate computer terminals, where they read a set of online instructions and worked independently. Of the 120 participants, 70 were female, and the average age of all participants was 18.5 years.[13] This study received ethics clearance from the university in which the experiment was conducted.

### Experimental Design and Procedures

The experiment has a 3 (incentive scheme) × 2 (training) design. *Incentive Scheme* is manipulated at three levels: flat wage, piece-rate pay, and flat wage plus public recognition. *Divergent Thinking Training* is manipulated at two levels: training present versus training absent. Participants were randomly assigned to one of the six conditions during each session. Participants first learned about their respective incentive schemes, and comprehension check questions followed to correct any misunderstandings. Participants in the training-present conditions then completed the training program. Those in the training-absent conditions worked on an unrelated exercise that took the same average time to complete. All participants attempted a practice problem and reviewed its solution. They had seven minutes to solve each of six insight problems (see Appendix A for the link to the downloadable Experiment Instrument document) and could advance to the next problem once they were satisfied with their submitted solutions or had given up looking for a solution.[14] The problems were assigned in the same order for everyone, and participants could not go back to previous problems. In a pretest, I compared the current order with a random order and found that training does not interact with order to affect performance. Following each problem, participants responded to questions about whether they had seen the problem before and whether they remembered the solution. After participants had completed the six insight problems, they responded to a post-experimental questionnaire. Cash payments were provided one week after the last experimental session.

#### *Incentive Scheme*

The three incentive schemes are operationalized as flat wage, piece-rate pay, and flat wage plus public recognition. The flat wage scheme paid participants $15 regardless of their performance on the problem-solving task. The piece-rate pay scheme paid a base wage of $6 and another $3 for each problem solved (maximum remuneration was $24; expected remuneration was $15).[15] The flat wage plus public recognition scheme paid participants $15, and informed them that the five top performers (out of 20) would be congratulated and their names and scores sent via email to everyone in the same condition once performance was assessed.[16] See Appendix A for the link to the instructions provided to participants about the incentive schemes. All participants completed a quiz in which they answered multiple-choice questions about how they were to be paid. Further, participants in the flat wage plus public recognition condition answered a multiple-choice question about whether and how they would be given performance feedback. All participants were required to answer these questions correctly before moving on.

#### *Divergent Thinking Training*

In the training-present condition, participants read a modified version of McCaffrey's (2012) training module describing the generic parts technique (or GPT). The GPT instructs individuals to decompose, visually or on paper, an object to its more basic components, such as a ladder to rungs and rails. Moreover, individuals are asked to refer to these components by their physical properties rather than their intended uses (e.g., a rung of a ladder will be "a thin wooden rectangle"). Participants completed the exercises at their own pace. First, they were given an overview of the GPT. Second, they were provided with a comprehensive example of the GPT, including a tree diagram. Third, they practiced the GPT. Answers were provided after each

[13] Chen et al. (2012) find that gender is associated with performance on creative tasks. In the current study, gender was not correlated with insight problem-solving performance, so it was not included in the analyses.
[14] The seven-minute limit was introduced based on results reported in McCaffrey (2012) indicating that most individuals could finish an insight problem within that time.
[15] A pilot study was conducted to calibrate the amount of flat wage such that it equals the average pay of the piece-rate pay/training-present condition.
[16] A natural extension of the current design is to investigate the combination of piece-rate pay and public recognition since Tafkov (2013) finds that the combination of RPI and performance incentives heightens social comparison effort. Given resource constraints and in order to fully populate the existing six cells while maintaining randomized assignment, I decided not to include this additional condition.

exercise to reinforce learning. The average time to complete the training was just over nine minutes. (See Appendix A for the link to the details about the training module.)

In the training-absent condition, participants were asked to work on a word association task that was designed to take the same time to complete as learning the GPT. Participants in this condition were asked to rapidly type the first word they thought of after seeing a stimulus word. The word association task was developed by Christensen and Guilford (1958). Existing research shows that the exposure to the word association task does not impact performance on subsequent creative idea generation or creative problem-solving tasks (Chrysikou 2006).

### *Dependent Variable*

The dependent variable in this study is *Performance,* which is measured as the number of insight problems solved (out of six). To assess whether participants solved the problems, written responses were compared against the standard "best" answers to these insight problems (McCaffrey 2012). To score as "correct," the submitted answer must be able to satisfy all the constraints in the problem as well as the standard (designed) answer. Two independent raters who were unaware of the experimental conditions were recruited to evaluate the responses. These two raters, along with the researcher, coded participants' typed responses. Simple agreement percentages were calculated to measure consensus among the raters. The Cohen's kappa values between raters A and C (the researcher), raters B and C, and raters A and B are 0.91, 0.90, and 0.87, respectively, suggesting a high level of consensus. Coding differences were resolved through discussion, and if no consensus was reached, through majority rule. As a result of this process, with the exception of the practice problem, all the correct responses strongly resemble the standard answer.

### *Covariates*

Covariates include *Prior Experience* and *Age*. *Prior Experience* is the number of problems in the experiment that the participant reported having seen before and for which the participant recalled the solution. To individuals who have prior experience, the task would have become a memory task rather than a creative problem-solving task.[17] For remuneration purposes, however, participants were not penalized for having prior experience with the problems, so the risk of misreporting was minimal.

The second covariate is *Age*. *Age* may proxy for additional knowledge about objects in the problems, as well as for higher general problem-solving ability. In a pretest using an Amazon Mechanical Turk sample of 66 participants who attempted the same six problems, *Age* was positively related to performance.[18] It should be noted that the Mechanical Turk sample had a standard deviation in *Age* of 11 years, while this study showed little variation in *Age* (standard deviation = 2 years). Thus, age may not play a significant role in the current study.

## IV. RESULTS

### Tests of Hypotheses

Panel A of Table 1 shows the means (standard deviations) of the number of insight problems solved by condition. Figure 2 displays the means graphically. I find that, in the absence of divergent thinking training, those in the flat wage condition solved an average of 2.5 problems, which is the highest among the three incentive conditions. In the presence of divergent thinking training, those receiving a flat wage plus public recognition solved 3.45 problems, which is higher than the other two conditions. Most significantly, divergent thinking training increased the average performance of those receiving piece-rate pay from 1.5 to 3.05 problems. In comparison, divergent thinking training did not change the average performance of those receiving flat wages.

H1 predicts that, in the absence of divergent thinking training, creative problem-solving performance will be lower under piece-rate pay than under a flat wage. Table 1, Panel B provides the results of an ANCOVA with *Performance* as the dependent variable, *Incentive Scheme* and *Divergent Thinking Training* as independent variables, and *Prior Experience* and *Age* as covariates. The main effect of *Incentive Scheme* is not significant ($F = 2.17$; $p = 0.118$, two-tailed). However, since H1 is limited to the training-absent condition, the result from a simple contrast between the flat wage/training-absent and piece-rate pay/training-absent conditions provides a more appropriate test of this hypothesis. Panel C of Table 1 shows the weights

[17] The number of instances of prior experience is unevenly distributed across the conditions. In the training-absent conditions, the frequency of prior experience is 5, 2, and 1 for flat wage (no incentive), piece-rate pay, and flat wage plus public recognition conditions, respectively; in the training conditions, the frequency of prior experience is 6, 0, and 2, respectively.

[18] The pilot test was conducted to determine whether the presentation order of the problems would interact with the training manipulation. Two conditions were run with the problems presented in the current, as well as the reverse, order. No interaction effect was found.

**TABLE 1**

**The Effect of Incentive Schemes and Divergent Thinking Training on Performance**

**Panel A: Means (Standard Deviations) for *Performance*[a] (Problems Solved) (n = 120)**

| | *Flat Wage* | *Piece-Rate Pay* | *Flat Wage plus Public Recognition* | Total |
|---|---|---|---|---|
| Training Absent | 2.50<br>(1.23)<br>Cell A | 1.50<br>(1.32)<br>Cell B | 2.15<br>(1.50)<br>Cell C | 2.05<br>(1.40) |
| Training Present | 2.55<br>(1.64)<br>Cell D | 3.05<br>(1.70)<br>Cell E | 3.45<br>(1.64)<br>Cell F | 3.02<br>(1.67) |
| Total | 2.53<br>(1.43) | 2.28<br>(1.69) | 2.8<br>(1.68) | |

**Panel B: Analysis of Variance**

| Factor | df | Sum of Squares | F | p-value[e] |
|---|---|---|---|---|
| *Incentive Scheme*[b] | 2 | 8.85 | 2.17 | 0.118 |
| *Divergent Thinking Training*[c] | 1 | 27.52 | 13.72 | 0.001 |
| *Incentive Scheme* × *Divergent Thinking Training* | 2 | 16.38 | 4.31 | 0.016 |
| *Prior Experience*[d] | 1 | 15.98 | 12.27 | 0.001 |
| *Age*[d] | 1 | 6.31 | 3.80 | 0.054 |
| Error | 109 | 205.68 | | |

**Panel C: Planned Contrast**

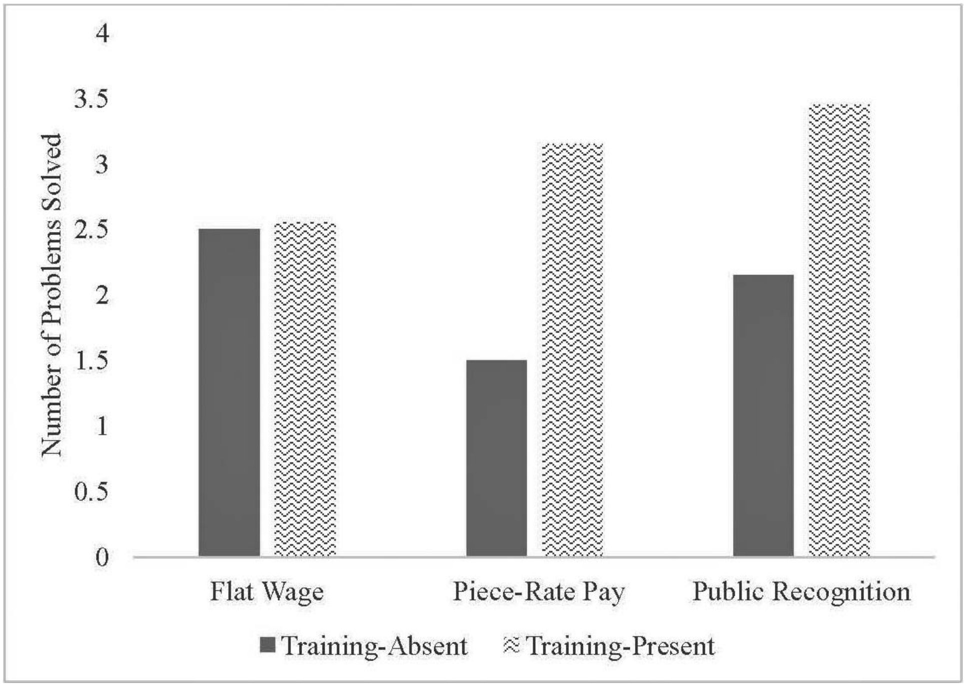
| | t-statistic | p-value |
|---|---|---|
| H1: *Flat Wage* versus *Piece-Rate Pay* in the absence of *Divergent Thinking Training* (Cell A > Cell B)<br>Contrast Weights (A = 1, B = −1, C = 0, D = 0, E = 0, F = 0) | 2.07 | **0.020** |
| RQ1: *Flat Wage* versus *Flat Wage plus Public Recognition* in the absence of *Divergent Thinking Training* (Cell A > Cell C)<br>Contrast Weights (A = 1, B = 0, C = −1, D = 0, E = 0, F = 0) | 0.06 | 0.951 |
| H2a: Comparing the differences between the *Piece-Rate Pay* and *Flat Wage* conditions in the presence and absence of the *Divergent Thinking Training* (Cell B − Cell A) < (Cell E − Cell D)<br>Contrast Weights (A = −1, B = 1, C = 0, D = −1, E = 1, F = 0) | 2.89 | **0.002** |
| H2b: Comparing the differences between the *Flat Wage plus Public Recognition* and *Flat Wage* conditions in the presence and absence of the *Divergent Thinking Training* (Cell C − Cell A) < (Cell F − Cell D)<br>Contrast Weights (A = −1, B = 0, C = 1, D = −1, E = 0, F = 1) | 1.87 | **0.032** |

[a] Total number of problems solved per individual.
[b] *Incentive Scheme*: 0 = *Flat Wage*, 1 = *Piece-Rate Pay*, 2 = *Flat Wage plus Public Recognition*.
[c] *Divergent Thinking Training*: 0 = Training Absent, 1 = Training Present.
[d] Control Variables: *Age* is the actual age of the participant; *Prior Experience* counts the number of times a participant replies "Yes" to a question of whether the participant has seen the problem previously.
[e] Reported p-values are two-tailed unless testing a one-tailed prediction, as signified in bold.

assigned to each condition for the contrast tests. The first contrast test result suggests that individuals who received piece-rate pay solved fewer insight problems than those who received a flat wage ($t = 2.07$; $p = 0.020$, one-tailed). On average, participants who did not receive training solved 1.50 problems with piece-rate pay compared to 2.50 problems solved by those working for the flat wage. This result supports H1.

RQ1 relates to whether, in the absence of divergent thinking training, a flat wage plus public recognition will decrease creative problem-solving performance. Panel A of Table 1 shows that those who worked under the flat wage plus public

**FIGURE 2**
**The Effect of Incentive Schemes and Divergent Thinking Training on Performance**




*Incentive scheme* is manipulated at three levels. Participants in the flat wage condition received $15; those in the piece-rate pay condition received a flat wage of $6 plus $3 for every problem they solved; and those in the flat wage plus public recognition condition received a flat wage of $15, plus the opportunity to be recognized as a top performer (top 25 percent). *Divergent Thinking Training* is manipulated at two levels. Participants in the training-present condition received the GPT training instructions and exercises. Participants in the training-absent condition received the word association task. *Performance* is defined as the total number of problems solved per individual.

recognition condition solved an average of 2.15 problems (compared to 2.5 under the flat wage only condition). The contrast test in Panel C shows that the difference between these two conditions is not significant ($t = 0.06$; $p = 0.951$, two-tailed). These results suggest that the addition of public recognition to a flat wage generates a neutral effect on creative problem-solving performance.[19]

H2a predicts that, compared to a flat wage, piece-rate pay will have a more positive effect on creative problem-solving performance when combined with divergent thinking training. As reported in Panel B of Table 1, I observe a significant *Divergent Thinking Training* main effect ($F = 13.72$; $p < 0.001$, two-tailed), qualified by a significant *Incentive Scheme* by *Divergent Thinking Training* interaction ($F = 4.31$; $p = 0.016$, two-tailed). Specifically, in the training-present condition, piece-rate pay results in a performance level of 3.05 problems solved, whereas the flat wage results in 2.55 problems solved. The contrast test in Panel C compares the differences in performance between these two incentive schemes in the training-present versus training-absent conditions. Consistent with H2a, I find a positive interaction between *Piece-Rate Pay* and *Divergent Thinking Training* ($t = 2.89$; $p = 0.002$, one-tailed).

H2b is similar to H2a in that it predicts that, in the presence of divergent thinking training, a flat wage plus public recognition will have a more positive effect on creative problem-solving performance than the flat wage only. As reported in Panel B of Table 1, individuals solved an average of 3.45 problems in the flat wage plus public recognition/divergent thinking training condition, while those in the flat wage/divergent thinking training condition solved 2.55 problems on average. Using the same contrast weights from the test devised for H2a, the contrast test in Panel C shows that there is a positive interaction

[19] A comparison of the piece-rate pay and the flat wage plus public recognition conditions in the absence of divergent thinking training shows that individuals receiving piece-rate pay performed worse than those receiving a flat wage plus recognition ($t = 2.00$; $p = 0.048$, two-tailed). However, it should be noted that those in the flat wage plus public recognition condition are guaranteed a fixed income, as well as public recognition if they do well, while neither is present in the piece-rate pay condition. Further research is needed to separately examine the effects of guaranteed pay and recognition potential.

between *Flat Wage plus Public Recognition* and *Divergent Thinking Training* (t = 1.87; p = 0.032, one-tailed). Overall, these results support both H2a and H2b.

Further, it should be noted that divergent thinking training does not, by itself, increase creative problem-solving performance. Compared to the flat wage without training condition, the addition of training barely affects the total number of problems solved (the *Flat Wage/No Training* and *Flat Wage/Divergent Thinking Training* conditions solved on average 2.50 and 2.55 problems, respectively).

### The Effects of Performance Incentives on Effort, and the Effect of Effort on Performance

On average, the provision of performance incentives should increase effort. My hypotheses predict that incentives will fail to promote creative problem solving, not because incentives discourage effort but because they will direct effort toward convergent rather than divergent thinking. Although it is difficult to measure the amount of cognition an individual allocates to different types of thinking, an examination of how performance incentives affect effort and how effort translates to performance can shed some light on whether individuals shifted toward convergent thinking.

*Effort* is measured as the average amount of time, in seconds, that participants spend on an insight problem. Participants were allowed seven minutes per problem, but not everyone used the full seven minutes. The actual time taken represents a combination of activities: reading the question, generating ideas, validating ideas, and typing out solutions. Panel A of Table 2 provides the descriptive statistics for *Effort* by condition. Panel B displays the results of an ANCOVA with *Effort* as the dependent variable, *Incentive Scheme* and *Divergent Thinking Training* as the independent variables, and *Prior Experience, Age,* and *Practice Problem Time* as covariates. *Prior Experience* and *Age* are included for consistency with the model in Table 1. *Practice Problem Time* is included to control for individual differences in the intrinsic motivation of individuals toward completing the task. Since performance on the practice problem was not rewarded, the time spent on the practice problem could capture the variation in intrinsic motivation toward this task.

Consistent with my expectations, there is an *Incentive Scheme* main effect (F = 3.78; p = 0.026, two-tailed). Panel C displays the results of *post hoc* pairwise comparisons among the three incentive schemes. Both piece-rate pay and a flat wage plus public recognition increase the amount of effort spent on the problems more than a flat wage does (the respective p-values are 0.043 and 0.072, Bonferroni adjusted). There is no difference in effort between the two incentive conditions. *Divergent Thinking Training* does not have a significant effect on *Effort*. Moreover, I do not find an *Incentive Scheme* by *Divergent Thinking Training* interaction.

Next, I examine whether an increase in effort leads to an increase in creative problem-solving performance. My theory suggests that increases in effort are less likely to be beneficial when individuals do not take the time to engage in divergent thinking. To test this prediction, I first split the data on the presence of *Divergent Thinking Training* and then separately regress *Performance* on *Effort* while controlling for *Prior Experience* and *Age*. Table 3 provides the results of these two regressions. In the training-absent condition, *Effort* is not significantly associated with *Performance* (t = 0.98; p = 0.331, two-tailed). In the training-present condition, *Effort* is positively associated with *Performance* (t = 2.15; p = 0.036). Overall, results from Tables 2 and 3 are consistent with my theory that performance incentives increase the amount of effort spent on the task, but effort needs to be directed toward both divergent and convergent thinking to increase performance. When divergent thinking training is received, individuals are more likely to convert their increases in effort to achieve increases in performance.

### Do Performance Incentives Affect Training Effort and Training Usage?

In my study, participants learned about their incentive scheme before they entered the training stage of the experiment. Although it is common for employees to go into training knowing their compensation schemes (Kumar, Sunder, and Leone 2015), this design choice raises the possibility that incentives increase attentiveness during training, or increase the motivation to use training materials. Cropley's (2006) model focuses on the synergy between divergent and convergent thinking but does not make any predictions about whether incentives can increase divergent thinking through training. To investigate this possibility, I examine participants' behavior during the training stage and their responses to the post-experimental questionnaire. I do not examine the training-absent conditions as the participants in those conditions performed a different task during the training stage (i.e., the word association test). Time spent during training is used to represent training effort, and the practice problem solution rate is used to proxy for learning during training. To measure training usage, I aggregate the answers to three post-experimental questions asking whether and how participants used what they learned during the training exercise.[20]

[20] Cronbach's alpha for these three questions is 0.704, suggesting adequate measurement consistency.

**TABLE 2**

**The Effect of Incentive Schemes and Divergent Thinking Training on Effort**

**Panel A: Means (Standard Deviation) for *Effort* (n = 120)[a,b,c]**

| | ***Flat Wage*** | ***Piece-Rate Pay*** | ***Flat Wage plus Public Recognition*** | **Average** |
|---|---|---|---|---|
| Training Absent | 226.67 | 269.41 | 263.47 | 253.19 |
| | (79.28) | (65.19) | (69.29) | (72.82) |
| Training Present | 250.79 | 279.79 | 286.26 | 272.27 |
| | (81.87) | (62.78) | (74.50) | (73.87) |
| Average | 238.73 | 274.59 | 274.87 | |
| | (80.48) | (63.39) | (71.94) | |

**Panel B: Analysis of Variance**

| **Factor** | **df** | **Sum of Squares** | **F** | **p-value[f]** |
|---|---|---|---|---|
| *Incentive Scheme* | 2 | 33438.13 | 3.78 | 0.026 |
| *Divergent Thinking Training* | 1 | 11893.63 | 2.69 | 0.104 |
| *Incentive Scheme* × *Divergent Thinking Training* | 2 | 3082.84 | 0.35 | 0.706 |
| *Prior Experience*[d] | 1 | 3707.99 | 0.84 | 0.362 |
| *Age*[d] | 1 | 7359.76 | 1.66 | 0.200 |
| *Practice Problem Time*[e] | 1 | 100470.05 | 22.72 | < 0.001 |
| Error | 111 | 490849.49 | | |

**Panel C: Pairwise Comparisons**

| | **Adjusted Mean Difference** | **p-value (Bonferroni Adjusted)** |
|---|---|---|
| *Flat Wage* versus *Piece-Rate Pay* | 38.79 | 0.043 |
| *Flat Wage* versus *Flat Wage plus Public Recognition* | 34.99 | 0.072 |
| *Piece-Rate Pay* versus *Flat Wage plus Public Recognition* | 3.80 | 1.000 |

[a] *Effort* is defined as average time (in seconds) per problem.
[b] *Incentive Scheme*: 0 = *Flat Wage*, 1 = *Piece-Rate Pay*, 2 = *Flat Wage plus Public Recognition*.
[c] *Divergent Thinking Training*: 0 = Training Absent, 1 = Training Present.
[d] *Age* is the actual age of the participant; *Prior Experience* counts the number of times a participant replies "Yes" to a question of whether the participant has seen the problem previously.
[e] *Practice Problem Time* is the number of seconds that participants spent on the practice problem. It controls for individual differences in reading time and deliberateness because the practice problem is not incentivized.
[f] Reported p-values are two-tailed.

Panel A of Table 4 shows the descriptive statistics for my measures of training effort, practice problem performance, and the three training usage questions. On average, participants spent nine minutes on the training module, and only 50 percent successfully solved the practice problem. In general, participants agreed that they used the GPT method (the average responses to Q4 and Q6 are 3.73 and 3.80, respectively—both higher than the median of 3 [neither agree nor disagree] on a five-point Likert scale). However, they did not spend time drawing the tree diagrams as demonstrated in the training module (average response to Q5 is 2.2). Panel B shows the results of t-tests comparing responses under the flat wage with the average of the piece-rate pay and a flat wage plus public recognition conditions, which are combined because they are both performance based and have the same effect on effort. I do not find significant differences among these conditions. In summary, these results suggest that incentives do not increase effort during the training module, nor do they significantly increase training usage. The most likely explanation for the performance increase is that the training exposed individuals to a different way of thinking, raising the level of divergent thinking skills. As divergent thinking skills increase, effort spent toward convergent thinking becomes more productive.

**TABLE 3**

**The Effect of Effort on Creative Problem-Solving Performance**

| | | Dependent Variable: *Performance* | | | |
|---|---|---|---|---|---|
| | | **B** | **SE** | **t** | **p-value** |
| Training Absent | (Constant) | 2.33 | 1.43 | 1.63 | 0.110 |
| | *Effort*[a] | 0.00 | 0.00 | 0.98 | 0.331 |
| | *Prior Experience*[b] | 1.64 | 0.49 | 3.37 | 0.001 |
| | *Age*[c] | −0.06 | 0.06 | −0.93 | 0.356 |
| Training Present | (Constant) | 10.23 | 4.76 | 2.15 | 0.036 |
| | *Effort* | 0.01 | 0.00 | 2.15 | 0.036 |
| | *Prior Experience* | 0.77 | 0.55 | 1.40 | 0.167 |
| | *Age* | −0.49 | 0.26 | −1.89 | 0.064 |

[a] Average time (in seconds) per problem.
[b] *Prior Experience* counts the number of times a participant replies "Yes" to a question of whether the participant has seen the problem previously.
[c] *Age* is the self-reported age of the participant at the time of attending the study.

**Do Results Depend on Task Difficulty?**

Another potential concern with these results is that they may vary with task difficulty. If the findings only apply to less difficult problems, they would be less valuable to firms interested in solving more difficult problems to achieve greater innovation. To address this concern, I first calculate the percentage of participants who successfully solve each problem. Panel A of Table 5 shows that, consistent with data provided in McCaffrey (2012), the watch, stuck truck, and candle problems are

**TABLE 4**

**The Effect of Incentives on Training**

**Panel A: Means (Standard Deviations) of Training Performance Variables (n = 60)**

| | ***Flat Wage*** **A (n = 20)** | ***Piece-Rate Pay*** **B (n = 20)** | ***Flat Wage plus Public Recognition*** **C (n = 20)** | ***Conditions*** **B and C (n = 40)** |
|---|---|---|---|---|
| Time [Seconds] Spent during Training | 514.35 | 554.87 | 560.08 | 557 |
| | (146.13) | (147.73) | (171.78) | (159.21) |
| Practice Problem Solve Rate | 50% | 55% | 55% | 55% |
| | (0.51) | (0.50) | (0.50) | (0.50) |
| Self-Reported Training Usage [Likert Scale 1 to 5] | | | | |
| Q4: I used what I learned from the generic parts technique (GPT) when attempting to solve the problems assigned to me. | 3.35<br>(1.04) | 3.95<br>(0.83) | 3.5<br>(1.10) | 3.73<br>(0.99) |
| Q5: I applied the GPT by actually drawing tree diagrams for each problem. | 1.95<br>(1.00) | 2.1<br>(0.97) | 2.3<br>(0.98) | 2.2<br>(0.97) |
| Q6: I applied the GPT by decomposing the objects described in each problem into smaller parts. | 3.5<br>(1.10) | 3.85<br>(1.09) | 3.7<br>(0.92) | 3.8<br>(1.00) |
| Training Usage (Total of Q4 to Q6) | 8.8 | 9.9 | 9.5 | 9.7 |
| | (2.46) | (2.07) | (2.61) | (2.33) |

**Panel B: t-tests between Flat Wage Conditions and the Average of Piece-Rate Pay and Flat Wage Plus Public Recognition Conditions**

| | **t-statistic** | **p-value** |
|---|---|---|
| Time [Seconds] Spent during Training | 1.48 | 0.144 |
| Practice Problem Solve Rate | 0.51 | 0.610 |
| Training Usage | 1.38 | 0.172 |

**TABLE 5**

**The Effect of Incentive Schemes and Divergent Thinking Training on Performance**

**Panel A: Number (Percentage) of Participants Solving Each Problem**

| | Participants Who Solved | |
|---|---|---|
| **Problem** | **Number** | **Percentage** |
| Watch | 88 | 0.73 |
| Truck | 70 | 0.58 |
| Candle | 55 | 0.46 |
| Tower | 35 | 0.29 |
| Rings | 24 | 0.20 |
| Lamp | 34 | 0.28 |

**Panel B: Means (Standard Deviations) for *Performance* on the Easy and Hard Problems[a] (Problems Solved) (n = 120)**

| | ***Flat Wage*** | | ***Piece-Rate Pay*** | | ***Flat Wage plus Public Recognition*** | |
|---|---|---|---|---|---|---|
| | **Easy** | **Hard** | **Easy** | **Hard** | **Easy** | **Hard** |
| Training Absent | 1.95 | 0.60 | 1.15 | 0.35 | 1.7 | 0.45 |
| | (0.89) | (0.60) | (0.93) | (0.59) | (0.87) | (0.76) |
| Training Present | 1.8 | 0.75 | 1.85 | 1.2 | 2.1 | 1.35 |
| | (1.15) | (0.72) | (0.93) | (1.15) | (0.91) | (1.04) |
| Average | 1.88 | 0.68 | 1.5 | 0.78 | 1.9 | 0.9 |
| | (1.02) | (0.66) | (0.99) | (1.00) | (0.90) | (1.01) |

[a] Easy problems include the watch, truck, and candle problems, with solution rates close to or above 50 percent. Hard problems include the tower, rings, and lamp problems, with solution rates lower than 30 percent.

relatively easy, with solution rates close to or higher than 50 percent. The tower, rings, and desk lamp problems are harder, with solution rates between 20 and 30 percent. Therefore, I classify the tasks into easy and hard problem groups. Panel B shows the number of problems solved for the easy versus hard problems, by condition. In untabulated analyses, I run separate ANCOVAs similar to the one in Table 1 with *Performance* on the easy and hard problems as the dependent variable. I find significant interaction effects between *Incentive Scheme* and *Divergent Thinking Training* in both models. In particular, when *Performance* on the hard problems is the dependent variable, the effect of piece-rate pay (compared to the effect of a flat wage) is more positive in the presence of training than in its absence ($F = 4.93$; $p = 0.014$, one-tailed). Similarly, the effect of a flat wage plus public recognition (compared to the effect of a flat wage only) is more positive in the presence of training ($F = 3.73$; $p = 0.028$, one-tailed). As a result of these tests, I conclude that the positive interaction effect between performance incentives and divergent thinking training does not diminish as task difficulty increases.

## V. DISCUSSION AND CONCLUSION

I report the results of an experiment in which individuals are asked to solve insight problems that involve uncommon or creative uses of common objects. In this task setting, I examine the effects of incentives and divergent thinking training. In the absence of divergent thinking training, neither incentive has a positive effect on creative problem-solving performance. Piece-rate pay results in lower performance than a flat wage, despite an increase in effort spent on the task. However, piece-rate pay has a greater positive effect on performance when combined with divergent thinking training than it does without training. I also study the effect of public recognition on creative problem solving, with and without divergent thinking training. In the absence of training, a flat wage plus public recognition does not lower performance. Similar to the effect of piece-rate pay, when combined with divergent thinking training, a flat wage plus public recognition has a more positive effect on performance than a flat wage alone. The direction of the interaction is similar to the effect of piece-rate pay, although the effect size is smaller.

These results can be better understood in the context of Cropley's (2006) model of creativity, which describes the creative process as seven different phases requiring different levels of divergent and convergent thinking. Insight problems are suitable for examining the idea-generation and idea-verification phases. Individuals must first avoid functional fixation and then examine potential solutions against the moderately clear constraints in insight problems. Insufficient divergent thinking leads to not enough ideas during the idea-generation phase; insufficient convergent thinking may lead to impractical ideas that do not satisfy the problem constraints. The finding that piece-rate pay decreases performance in the absence of divergent thinking training suggests that such incentives can motivate individuals to misallocate their efforts. It is likely that piece-rate pay increases convergent thinking at a cost to divergent thinking during the idea-generation phase and, as a result, insufficient divergent thinking reduces creative problem-solving performance.

My study suggests that performance incentives may not have a direct effect on divergent thinking. Firms could rely on other means such as training to boost divergent thinking and restore a balance between divergent and convergent thinking. Without this balance, individuals may over-allocate their effort to convergent thinking. The positive interaction between piece-rate pay and divergent thinking training suggests that convergent and divergent thinking may be more in balance when training and incentives are combined. Similarly, the positive interaction between a flat wage plus public recognition and divergent thinking training suggests that a firm may use nonmonetary incentives to increase creativity problem-solving performance. In addition, the finding that recognition does not decrease performance over a flat wage in the training-absent condition suggests that public recognition is the less risky motivator and may do a better job balancing divergent and convergent thinking among employees.

This study presents several implications for management accounting literature. First, I introduce insight problems to the category of creative tasks examined in accounting research. I show that, for creative tasks that have moderate to high levels of constraint clarity, piece-rate pay can both hurt and help performance depending on whether divergent thinking training is provided. These results are contrasted with experimental studies from Kachelmeier et al. (2008) and Kachelmeier and Williamson (2010) that examine creative tasks that are more open-ended with low constraint clarity and that show that monetary incentives tied to creative performance have little effect on actual performance. The collective evidence ultimately suggests that firms should consider the type of creative task they assign employees before selecting incentive schemes.

Second, my study is the first to examine public recognition—a nonmonetary incentive— with a piece-rate pay—a monetary incentive—by comparing them both to a flat wage scheme. Public recognition's value lies in employees' desire to be seen as skilled at an important task. For example, in academy or industry research, the notoriety affected by "best paper" or "new product of the year" tags may be more valuable to the individual than monetary prizes. The effect of public recognition is different from that of piece-rate pay. In the absence of divergent thinking training, public recognition does not negatively affect performance compared to a flat wage, unlike piece-rate pay. In the presence of training, a flat wage plus public recognition generates a positive effect on performance compared to a flat wage alone. Organizations that wish to incentivize employees but also wish to control costs may consider using recognition rather than monetary bonuses.

Third, prior research has examined the effect of recognition on effort exertion, effort allocation, and employee cooperation (e.g., Kosfeld and Neckermann 2011; Tafkov 2013; Wang 2017), but the tasks in these studies are more algorithmic and require lower creative problem-solving abilities. My study extends the research on recognition to the creative problem-solving task setting. I show that public recognition appears to be at least as effective as piece-rate pay at motivating higher creative problem-solving performance. Individuals may find public recognition for their creative problem-solving abilities particularly desirable as it differentiates them from other employees and affords them higher social status (Boland and Tenkasi 1995).

The results of my study should be interpreted in light of the following limitations. First, this study does not examine tournament incentives, which combine relative performance information and monetary incentives. Although tournament incentives are often used in innovation contests, the ways in which they affect divergent thinking and convergent thinking require further clarification. Second, my study uses undergraduate students with similar ages, backgrounds, and educational experiences. In practice, firms may screen for individuals with higher divergent thinking skills rather than train everyone indiscriminately. My theory does not distinguish between skills acquired from on-the-job training and skills from natural abilities: more research is needed to examine the potential synergistic effect of incentives and employee screening programs. Third, this study does not examine the combination of piece-rate pay and public recognition. Prior research suggests that piece-rate pay may moderate the effect of relative performance information (Tafkov 2013). Finally, this study does not examine any group processes (cf. Chen et al. 2012). Future research can study how group processes change the effect of incentives on divergent and convergent thinking. Notwithstanding these limitations, this study contributes to a better understanding of how incentives affect creative problem-solving performance.

## REFERENCES

Alderfer, C. P. 1972. *Existence, Relatedness, and Growth: Human Needs in Organizational Settings*. New York, NY: Free Press.

Amabile, T. M. 1996. *Creativity in Context: Update to the Social Psychology of Creativity*. Boulder, CO: Westview Press.

Amabile, T. M., B. A. Hennessey, and B. S. Grossman. 1986. Social influences on creativity: The effects of contracted-for reward. *Journal of Personality and Social Psychology* 50 (1): 14–23. https://doi.org/10.1037/0022-3514.50.1.14

Ansburg, P. I., and R. I. Dominowski. 2000. Promoting insightful problem solving. *The Journal of Creative Behavior* 34 (1): 30–60. https://doi.org/10.1002/j.2162-6057.2000.tb01201.x

Ashraf, N., O. Bandiera, and S. S. Lee. 2014. Awards unbundled: Evidence from a natural field experiment. *Journal of Economic Behavior & Organization* 100: 44–63. https://doi.org/10.1016/j.jebo.2014.01.001

Ashton, R. H. 1990. Pressure and performance in accounting decision settings: Paradoxical effects of incentives, feedback, and justification. *Journal of Accounting Research* 28: 148–180. https://doi.org/10.2307/2491253

Awasthi, V., and J. Pratt. 1990. The effects of monetary incentives on effort and decision performance: The role of cognitive characteristics. *The Accounting Review* 65 (4): 797–811.

Bailey, C. D., N. J. Fessler, and B. K. Laird. 2015. *Examining the effects of performance-based pay and performance monitoring on task performance*. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2645380

Beckers, N., M. Cools, and A. Van Den Abbeele. 2010. The impact of incentives on creativity: A literature review. *Review of Business and Economics* 55 (4): 463–483.

Boland, R. J., Jr., and R. V. Tenkasi. 1995. Perspective making and perspective taking in communities of knowing. *Organization Science* 6 (4): 350–372. https://doi.org/10.1287/orsc.6.4.350

Bonner, S. E., and G. B. Sprinkle. 2002. The effects of monetary incentives on effort and task performance: Theories, evidence, and a framework for research. *Accounting, Organizations and Society* 27 (4/5): 303–345. https://doi.org/10.1016/S0361-3682(01)00052-6

Bonner, S. E., R. Hastie, G. B. Sprinkle, and S. M. Young. 2000. A review of the effects of financial incentives on performance in laboratory tasks: Implications for management accounting. *Journal of Management Accounting Research* 12 (1): 19–64. https://doi.org/10.2308/jmar.2000.12.1.19

Burroughs, J. E., D. W. Dahl, C. P. Moreau, A. Chattopadhyay, and G. J. Gorn. 2011. Facilitating and rewarding creativity during new product development. *Journal of Marketing* 75 (4): 53–67. https://doi.org/10.1509/jmkg.75.4.53

Chen, C. X., M. G. Williamson, and F. H. Zhou. 2012. Reward system design and group creativity: An experimental investigation. *The Accounting Review* 87 (6): 1885–1911. https://doi.org/10.2308/accr-50232

Christensen, P. R., and J. P. Guilford. 1958. *Creativity/Fluency Scales*. Beverly Hills, CA: Sheridan Supply.

Chrysikou, E. G. 2006. When shoes become hammers: Goal-derived categorization training enhances problem-solving performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 32 (4): 935–942. https://doi.org/10.1037/0278-7393.32.4.935

Chu, Y., and J. N. Macgregor. 2011. Human performance on insight problem solving: A review. *The Journal of Problem Solving* 3 (2): 119–150. https://doi.org/10.7771/1932-6246.1094

Cropley, A. 2006. In praise of convergent thinking. *Creativity Research Journal* 18 (3): 391–404. https://doi.org/10.1207/s15326934crj1803_13

de Vericourt, F., J. Hales, G. Hilary, and J. Samet. 2017. *Can capital constraints restrain creativity? The spillover effect of budget constraints on employee creativity*. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2998114

Dewett, T. 2007. Linking intrinsic motivation, risk taking, and employee creativity in an R&D environment. *R&D Management* 37 (3): 197–208. https://doi.org/10.1111/j.1467-9310.2007.00469.x

Dow, G. T., and R. E. Mayer. 2004. Teaching students to solve insight problems: Evidence for domain specificity in creativity training. *Creativity Research Journal* 16 (4): 389–398. https://doi.org/10.1080/10400410409534550

Duncker, K. 1945. On problem solving. *Psychological Monographs* 58 (5): 270. https://doi.org/10.1037/h0093599

Ederer, F., and G. Manso. 2013. Is pay for performance detrimental to innovation? *Management Science* 59 (7): 1496–1513. https://doi.org/10.1287/mnsc.1120.1683

Eisenberger, R., and S. Armeli. 1997. Can salient reward increase creative performance without reducing intrinsic creative interest? *Journal of Personality and Social Psychology* 72 (3): 652–663. https://doi.org/10.1037/0022-3514.72.3.652

Festinger, L. 1954. A theory of social comparison processes. *Human Relations* 7 (2): 117–140. https://doi.org/10.1177/001872675400700202

Glucksberg, S. 1962. The influence of strength of drive on functional fixedness and perceptual recognition. *Journal of Experimental Psychology* 63 (1): 36–41. https://doi.org/10.1037/h0044683

Grabner, I. 2014. Incentive system design in creativity-dependent firms. *The Accounting Review* 89 (5): 1729–1750. https://doi.org/10.2308/accr-50756

Hannan, R. L., R. Krishnan, and A. H. Newman. 2008. The effects of disseminating relative performance feedback in tournament and individual performance compensation plans. *The Accounting Review* 83 (4): 893–913. https://doi.org/10.2308/accr.2008.83.4.893

Kachelmeier, S. J., and M. G. Williamson. 2010. Attracting creativity: The initial and aggregate effects of contract selection on creativity-weighted productivity. *The Accounting Review* 85 (5): 1669–1691. https://doi.org/10.2308/accr.2010.85.5.1669

Kachelmeier, S. J., B. E. Reichert, and M. G. Williamson. 2008. Measuring and motivating quantity, creativity, or both. *Journal of Accounting Research* 46 (2): 341–373. https://doi.org/10.1111/j.1475-679X.2008.00277.x

Kahney, L. 2006. *Straight dope on IPod's birth*. Available at: https://www.wired.com/2006/10/straight-dope-on-the-ipods-birth/

Kilgour, M., and S. Koslow. 2009. Why and how do creative thinking techniques work? Trading off originality and appropriateness to make more creative advertising. *Journal of the Academy of Marketing Science* 37 (3): 298–309. https://doi.org/10.1007/s11747-009-0133-5

Kosfeld, M., and S. Neckermann. 2011. Getting more work for nothing? Symbolic awards and worker performance. *American Economic Journal: Microeconomics* 3 (3): 86–99. https://doi.org/10.1257/mic.3.3.86

Kumar, V., S. Sunder, and R. P. Leone. 2015. Who's your most valuable salesperson? *Harvard Business Review* 93 (April): 62–68.

Libby, R., R. Bloomfield, and M. W. Nelson. 2002. Experimental research in financial accounting. *Accounting, Organizations and Society* 27 (8): 775–810. https://doi.org/10.1016/S0361-3682(01)00011-3

Lourenço, S. M. 2016. Monetary incentives, feedback, and recognition—Complements or substitutes? Evidence from a field experiment in a retail services company. *The Accounting Review* 91 (1): 279–297. https://doi.org/10.2308/accr-51148

McCaffrey, T. 2012. Innovation relies on the obscure: A key to overcoming the classic problem of functional fixedness. *Psychological Science* 23 (3): 215–218. https://doi.org/10.1177/0956797611429580

McCaffrey, T., and S. Krishnamurty. 2014. The obscure features hypothesis in design innovation. *International Journal of Design Creativity and Innovation* 3 (1): 1–28. https://doi.org/10.1080/21650349.2014.893840

McClelland, D. C. 1967. *The Achievement Society*. Princeton, NJ: Free Press.

McPhee, G. P. 2017. *The effects of tangible rewards and payoff timing on performance of creative insight tasks*. Working paper, Florida International University.

Miller, J. 2007. *Toyota's suggestion system: 56 years and still going strong*. Available at: https://blog.gembaacademy.com/2007/12/09/toyotas_suggestion_system_56_years_and_still_going/

Nicholson, G. C. 1998. Keeping innovation alive. *Research Technology Management* 41 (3): 34–40. https://doi.org/10.1080/08956308.1998.11671207

Plumlee, R. D., B. A. Rixom, and A. J. Rosman. 2015. Training auditors to perform analytical procedures using metacognitive skills. *The Accounting Review* 90 (1): 351–369. https://doi.org/10.2308/accr-50856

Rietzschel, E. F., B. A. Nijstad, and W. Stroebe. 2010. The selection of creative ideas after individual idea generation: Choosing between creativity and impact. *British Journal of Psychology* 101 (1): 47–68.

Runco, M. A., and R. E. Charles. 1993. Judgments of originality and appropriateness as predictors of creativity. *Personality and Individual Differences* 15 (5): 537–546. https://doi.org/10.1016/0191-8869(93)90337-3

Sprinkle, G. B. 2008. Discussion of : "Measuring and motivating quantity, creativity, or both." *Journal of Accounting Research* 46 (2): 375–382. https://doi.org/10.1111/j.1475-679X.2008.00278.x

Tafkov, I. D. 2013. Private and public relative performance information under different compensation contracts. *The Accounting Review* 88 (1): 327–350. https://doi.org/10.2308/accr-50292

The University of British Columbia (UBC). 2018. *Library recognition awards*. Available at: https://about.library.ubc.ca/work-with-us/library-recognition-awards/

Vezina, K. 2011. Using games to get employees thinking. *MIT Technology Review* (August).

Wallas, G. 1926. *The Art of Thought*. Kent, U.K.: Solis Press.

Wang, L. W. 2017. Recognizing the best: The performance and sabotage effects of relative performance recognition. *Contemporary Accounting Research* 34 (2): 966–990. https://doi.org/10.1111/1911-3846.12292

Webb, R. A., M. G. Williamson, and Y. M. Zhang. 2013. Productivity-target difficulty, target-based pay, and outside-the-box thinking. *The Accounting Review* 88 (4): 1433–1457. https://doi.org/10.2308/accr-50436

Webb, M. E., D. R. Little, S. J. Cropper, and K. Roze. 2017. The contributions of convergent thinking, divergent thinking, and schizotypy to solving insight and non-insight problems. *Thinking & Reasoning* 23 (3): 235–258. https://doi.org/10.1080/13546783.2017.1295105

Wedell-Wedellsborg, T. 2017. Are you solving the right problem? *Harvard Business Review* (January/February): 76–83.

Weisberg, R. W. 2006. *Creativity: Understanding Innovation in Problem Solving, Science, Invention and the Arts*. 1st edition, Hoboken, NJ: Wiley.

Weisberg, R. W., and J. Suls. 1973. An information-processing model of Duncker's candle problem. *Cognitive Psychology* 4 (2): 255–276. https://doi.org/10.1016/0010-0285(73)90014-5

## APPENDIX A

jmar-52479_Experimental Instrument: http://dx.doi.org/10.2308/jmar-52479.s01