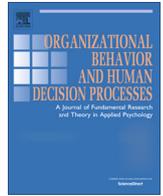




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## “Switching On” creativity: Task switching can increase creativity by reducing cognitive fixation

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## ABSTRACT

Whereas past research has focused on the downsides of task switching, the present research uncovers a potential upside: increased creativity. In two experiments, we show that task switching can enhance two principal forms of creativity—divergent thinking (Study 1) and convergent thinking (Study 2)—in part because temporarily setting a task aside reduces cognitive fixation. Participants who continually alternated back and forth between two creativity tasks outperformed both participants who switched between the tasks at their discretion and participants who attempted one task for the first half of the allotted time before switching to the other task for the second half. Importantly, Studies 3a–3d reveal that people overwhelmingly fail to adopt a continual-switch approach when incentivized to choose a task switching strategy that would maximize their creative performance. These findings provide insights into how individuals can “switch on” creativity when navigating multiple creative tasks.

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### 1. Introduction

In a world of hustle and bustle, switching back and forth between tasks—“task switching”—has become the work style of countless individuals (e.g., [Hallowell, 2005](#); [Perlow, 1999](#)). Bombarded with emails, phone calls, and meetings, managers and employees alike constantly shift their attention from one task to another ([Rosen, 2008](#)). Task switching is especially common among senior executives due to their numerous responsibilities ([Bandiera, Prat, Sadun, & Wulf, 2014](#); [Dean & Webb, 2011](#); [Ocasio, 1997](#)). In fact, the propensity to task switch emerges as early as adolescence: the average 7th–12th grader estimates spending 60% of the time they set aside for homework switching between homework and other activities (e.g., email, instant messaging; [Foehr, 2006](#)).

Not surprisingly, the increasing prevalence of task switching has prompted substantial research on its psychological consequences. For instance, past research has revealed that task switching increases susceptibility to distraction ([Leroy, 2009](#); [Ophir, Nass, & Wagner, 2009](#)), facilitates error-making ([Monsell, 2003](#)), slows execution ([Rogers & Monsell, 1995](#)), diminishes learning ([Hembrooke & Gay, 2003](#)), induces forgetting ([Einstein, McDaniel,](#)

[Williford, Pagan, & Dismukes, 2003](#); [Finstad, Bink, McDaniel, & Einstein, 2006](#)), lowers writing quality ([Foroughi, Werner, Nelson, & Boehm-Davis, 2014](#)), and heightens social anxiety ([Becker, Alzahabi, & Hopwood, 2013](#)).

While these studies clearly show the *negative* consequences of task switching, they leave open the question of whether there are any *benefits* of adopting a task-switching approach to one’s work. Using both divergent and convergent thinking measures of creativity, the present research demonstrates that continually switching between tasks can enhance *creative* performance by reducing cognitive fixation. Importantly, we also provide evidence that people undervalue the benefits of continually switching between creative tasks: when incentivized to maximize their performance on multiple creative tasks, people overwhelmingly fail to select the most effective work approach (i.e., continual task switching), suggesting that creative performance may improve if people are encouraged to switch between tasks at a greater frequency.

The present work contributes to research on workplace creativity in several important ways. First, it is among the first to empirically demonstrate an upside of task switching, while past research has almost exclusively focused on its downsides. As a result, the current findings offer a more balanced way of conceptualizing the effects of task switching. Second, although many modern employees increasingly switch among *multiple* tasks ([Rosen, 2008](#)) and although creativity is increasingly valuable to organizations ([IBM, 2010](#)), the scholarly literature is nearly silent about whether and how a task-switching approach shapes people’s

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creative work. To fill this gap in knowledge, we explore the implications of this workplace trend for creative performance. Third, we provide mechanistic evidence for why task switching may enhance creativity by introducing a novel metric of cognitive fixation, which past research has struggled to directly measure (e.g., Durso, Rea, & Dayton, 1994). Finally, we reveal that people erroneously expect that continually switching between tasks is less conducive to creative performance than alternative approaches (e.g., performing tasks in a serial fashion). This implies that individuals and organizations stand to profit from recognizing the creative benefits of task switching and adjusting the way they structure creative tasks at work.

### 1.1. Creativity at work

Creativity, typically defined as the production of ideas that are both novel and useful (Amabile, 1983), is critical to individual and organizational success (for reviews, see Hennessey & Amabile, 2010; Shalley & Gilson, 2004; Shalley, Zhou, & Oldham, 2004; Zhou & Hoever, 2014). According to a survey of over 1500 CEOs across 60 nations and 33 industries, creativity was identified as the most important leadership quality (IBM, 2010). Creative employees conceive ideas, products, services, procedures, and processes (Woodman, Sawyer, & Griffin, 1993) that can culminate in innovations that benefit the organization. From an interpersonal perspective, creative employees can inspire “outside-the-box thinking” among their colleagues to build an inventive environment within the organization (Shalley & Gilson, 2004). From an organizational perspective, creativity empowers the organization to survive and thrive in a dynamic world of unforeseen challenges and opportunities (Nonaka, 1991).

Although it is clear that creativity can influence critical organizational outcomes, many practitioners struggle to design work routines that foster creativity at work. For example, in a survey conducted with senior executives, over 70% championed workplace innovation as a vital driver of organizational success, yet 65% expressed a lack of confidence in their ability to promote it (Barsh, Capozzi, & Davidson, 2008).<sup>1</sup> In response to this knowledge gap, scholars have increasingly studied job design factors that enhance or hamper creativity. For example, studies have demonstrated that autonomous jobs make individuals more intrinsically motivated, which in turn enhances their creativity (Greenberg, 1992; Zhou, 1998). Other creativity-related job design factors include the spatial configuration of work settings (Shalley et al., 2004), job complexity (Hackman & Oldham, 1980), time pressure (Baer & Oldham, 2006; Byron, Khazanchi, & Nazarian, 2010), choice provision (Chua & Iyengar, 2006, 2008), and contingent rewards (Byron & Khazanchi, 2012).

One underexplored job design factor that may influence creativity is task switching. This oversight is puzzling not only because people often need to decide whether to adopt a switching versus serial approach to navigating multiple tasks, but also because there is a strong theoretical reason to suspect that switching between creative tasks increases the quality of output: by forcing individuals to temporarily put tasks aside, a continual-switch approach may elevate their creative performance by alleviating their tendency to cognitively “fixate” on ineffective ideas or problem-solving strategies (Chrysikou & Weisberg, 2005; Jansson & Smith, 1991; Purcell & Gero, 1996; Smith, 1995, 2003; Smith & Blankenship, 1991). In the sections that follow, we construct the theoretical case and test the hypothesis that performance on

creative tasks may improve when people continually switch between them because temporarily putting tasks aside reduces cognitive fixation.

### 1.2. Cognitive fixation impedes creativity

The notion that people commonly struggle to conceive creative solutions because they “fixate,” or fail to abandon inappropriate problem-solving angles, dates back to Luchins’s (1942) Einstellung (i.e., mental set) paradigm. In his seminal experiments, participants first attempted a series of problems whose solutions shared the same type of complex algorithm (i.e., the Einstellung algorithm). Strikingly, when participants later received a problem solvable with a much simpler algorithm, most of them “fixated” on the inefficient Einstellung algorithm and failed to utilize the simpler algorithm (see also Luchins & Luchins, 1959). Duncker (1945) advanced a similar explanation for poor problem-solving performance in his work on “functional fixedness,” or the inability to think beyond the conventional use of an object (i.e., to repurpose the object for a novel task setting). For example, Duncker (1945) demonstrated that when given a candle, a pack of matches, and a box of tacks, and challenged to affix the candle to the wall so that the candle burns properly and does not drip wax, a large percentage of individuals fixate on the tack box’s function as a repository for tacks and fail to realize that it can also be affixed to the wall and converted into a candleholder.

Building on these classic demonstrations, researchers have established cognitive fixation as a primary barrier to two principal forms of creativity: divergent thinking and convergent thinking (Smith & Blankenship, 1991; Smith, Ward, & Schumacher, 1993; Storm & Angello, 2010). Whereas divergent thinking involves the generation of *multiple* ideas in diverse directions (e.g., listing creative uses for a brick, Guilford, 1967), convergent thinking involves identifying the *unique* or *best* solution to a clearly defined problem (e.g., Duncker’s candle problem; Duncker, 1945). Both divergent and convergent thinking are considered critical yet distinct pathways to creativity, as identifying creative solutions often necessitates both diverging from previous approaches and converging on the optimal approach.

A wealth of evidence suggests that cognitive fixation impedes both divergent and convergent aspects of creativity. For instance, in the context of divergent thinking, individuals tend to generate fewer and less novel designs when the design instruction is accompanied by a pictorial example, because they are apt to generate ideas that conform to this example (Chrysikou & Weisberg, 2005; Jansson & Smith, 1991; Smith et al., 1993). Likewise, individuals generate fewer unique ideas when part of a brainstorming group compared to when brainstorming alone, because they fixate on the ideas proposed by other group members (Kohn & Smith, 2011).

In a similar vein, cognitive fixation is considered a barrier to solving problems that require convergent thinking. For instance, the classic convergent thinking task, the Remote Associates Test (RAT; Lu et al., 2017; Mednick, 1962), presents three cue words and asks the subject to conceive a fourth word that is associated with each of the three words (e.g., cue words: cheese, blood, print; solution: blue). The RAT can be challenging because people may first think of and fixate on a non-solution word that is strongly associated with just one of the cues (e.g., cheese—cake; blood—red; print—ink) instead of a word that is commonly associated with all three of them (Smith & Blankenship, 1991; Storm & Angello, 2010). Likewise, people commonly fail to solve insight problems because they fixate on unwarranted assumptions and strategies that interfere with the requisite insight (e.g., Duncker’s candle problem, Duncker, 1945).

<sup>1</sup> In the organizational behavior literature, innovation is typically defined as the successful implementation of creative ideas (e.g., Hennessey & Amabile, 2010), implying that creativity is the indispensable first stage of innovation (Zhou & Hoever, 2014).

### 1.3. Setting a task aside enhances creativity

An emerging body of research demonstrates that creative performance on both divergent and convergent thinking tasks can be improved if the effects of fixation are mitigated by setting a task aside, such as through breaks, distractions, or interruptions (Jett & George, 2003). Breaks are purported to free individuals from their fixated mindset by “reducing the ‘recency’ value of inappropriate strategies” (Ochse, 1990, p. 198). For example, brief breaks during brainstorming sessions can increase the number and variety of ideas generated (Kohn & Smith, 2011; Paulus & Brown, 2003). Similarly, performance on convergent thinking tasks (e.g., the RAT) improves as the break time between attempts is increased because cognitive fixation “wears off” over time (Smith & Blankenship, 1991).

Numerous studies on divergent and convergent thinking have found improvements in creative performance when subjects temporarily set aside the focal creative task to work on an unrelated one (e.g., Baird et al., 2012; Sio & Ormerod, 2009). For instance, Dijksterhuis and Meurs (2006) found that, compared to participants who started generating ideas immediately upon receiving the task, those who first engaged in a distractor task generated more novel ideas. This strategy of setting a problem aside to work on an unrelated task appears to be particularly beneficial for creative problem solving relative to other types of problem solving (Sio & Ormerod, 2009). The common theme in these studies is that setting a task aside may reduce cognitive fixation and enable individuals to approach the focal task with a fresh mind, thereby enhancing creative performance.

Noting the creative benefits of setting a task aside, Madjar and Shalley (2008) considered the possibility that people might have an easier time overcoming cognitive fixation if they switched between multiple creativity tasks. They speculated that “the optimal situation may be when individuals have the *choice* of switching tasks so that if they have reached a dead end in terms of generating ideas, they can switch as a way of refreshing themselves. . .” (p. 789). This led the authors to hypothesize that participants with discretion over when to switch from one creativity task to another would outperform participants without such discretion. Contrary to their hypothesis, no significant difference in creative performance was consistently observed between the two groups of participants. It is noteworthy, however, that this research design presupposes that individuals *recognize* the moments at which they are fixated on an ineffective problem-solving strategy and therefore *know* when they need to exercise the option of switching.

This presupposition is likewise seen in recent research by Smith, Gerkens, and Angello (2015) who found that continual switching was beneficial for divergent thinking tasks because breaks made it easier for people to restructure their search for ideas that had been previously inaccessible. Nonetheless, one limitation of this work is that the authors focused primarily on the efficacy of continual switching but did not include a discretionary-switch condition, again leaving open the question of whether people *know* when they need to exercise the option of switching.

The present research, by contrast, posits that people often fail to recognize moments of fixation and thus switch with insufficient frequency. If this is true, then instructing people to continually switch between tasks may indeed yield better creative performance than permitting them to switch at their own discretion.

### 1.4. The present research

The goal of the present investigation was two-fold. First, we tested the key hypothesis that performance on creativity tasks may improve when people continually switch between them

because temporarily putting tasks aside diminishes cognitive fixation. We argue that, when faced with multiple creativity tasks, persevering with one task may result in fixation on an ineffective or inefficient approach. In contrast, continually switching between tasks may help people abandon initial, unsuccessful problem-solving strategies and approach each task with fresh angles. To test this hypothesis, we examined the effects of task switching on both divergent thinking (Study 1) and convergent thinking (Study 2). In both studies, participants attempted two creativity tasks for a fixed amount of time under one of three conditions: continual-switch, discretionary-switch, or midpoint-switch. In the continual-switch condition, participants were instructed to alternate back and forth between the two creativity tasks (i.e., Task A, Task B, Task A, Task B, etc.). In the discretionary-switch condition, participants switched between the two tasks *at their discretion*. In the midpoint-switch condition, participants dedicated the first half of the allotted time to Task A and the second half to Task B. The midpoint-switch condition required participants to approach the tasks sequentially, thus serving as a baseline condition against which we compared performances in the continual-switch and discretionary-switch conditions. Based on our theoretical reasoning, we predicted that creative performance would be the highest in the continual-switch condition, as instructing participants to continually switch between two creativity tasks should mitigate cognitive fixation the most.

Importantly, evidence that continually switching between creativity tasks improves performance is particularly meaningful if people tend to *undervalue* the creative benefits afforded by continual task switching. Therefore, in addition to testing whether continually switching between two creativity tasks yields better outcomes (Studies 1 & 2), our second goal was to investigate whether people are *aware* of the creative benefits of this approach (Studies 3a–3d). That is, do people choose to switch continually when incentivized to maximize their creative performance? We predicted that people would erroneously expect continual switching to be less conducive to creative performance compared with discretionary and midpoint switching, and therefore overwhelmingly select the latter two approaches over continual switching when structuring their creative work.

Below we report all the studies we have conducted and all the measures we have collected to examine the relationship between task switching and creativity. In order to power each study at over 80%, we used G\*Power to determine the requisite sample sizes based on estimated medium-sized effects (Cohen, 1992). All participants consented to participating in our studies. Except where noted, all participants were included in our statistical analyses.

## 2. Study 1. The effects of task switching on divergent thinking

Study 1 tested whether having people continually switch between divergent thinking tasks enhances their creative performance. We randomly assigned participants to one of three conditions (continual-switch, discretionary-switch, or midpoint-switch) under which they completed two Alternative Uses Tasks (AUT, Guilford, 1967). The AUT requires participants to list creative uses for everyday objects, such as a brick or a toothpick.

To comprehensively assess the effects of task switching on divergent thinking, we had naïve coders who were blind to the study predictions and experimental conditions rate participants' responses in four different ways: (1) flexibility (i.e., the total number of unique usage categories), (2) novelty (i.e., the originality of the uses), (3) usefulness (i.e., the practicality of the uses), and (4) fluency (i.e., the total number of non-repeated uses).

We expected that participants in the midpoint-switch condition would switch least frequently because they would, by definition,

switch only once during the allotted time. Moreover, we predicted that participants in the discretionary-switch condition would switch less frequently than those in the continual-switch condition, because it seemed unlikely that the former group of participants would choose to switch after generating *each* use (i.e., the rate at which the continual-switch participants were instructed to switch).

Since setting a task aside likely mitigates the effects of cognitive fixation, we predicted that differences in switching frequency would translate into differences in the flexibility and novelty aspects of divergent thinking. Specifically, we expected participants who continually switched between two AUTs to generate a greater number of uses that were *categorically unique* and *novel* compared to participants who switched at their discretion and participants who switched at the halfway mark. On the other hand, since usefulness is often unrelated or inversely related to novelty (Goncalo, Flynn, & Kim, 2010; Rietzschel, Nijstad, & Stroebe, 2010), we did not expect more frequent task switching to improve the usefulness of ideas generated; thus, we predicted no significant differences in usefulness across the three conditions.

In light of our core theoretical arguments, we further hypothesized that a reduction in cognitive fixation would mediate the positive effects of task switching on flexibility and novelty. To ascertain this effect empirically, we devised a new metric of cognitive fixation: adjacency dissimilarity (AD). This measure captures whether a use generated in serial position  $K$  is functionally equivalent to the use generated at serial position  $K-1$  (i.e., whether the participant was “fixated” on a preceding response when generating a current response). If participants in the continual-switch condition switch more frequently, they should be less fixated on (and thus less influenced by) the previous responses they generated (i.e., higher adjacency dissimilarity).

With regard to *fluency*, we predicted that continual task switching would have a negative effect for two reasons. First, continually switching between two tasks requires participants to cognitively “switch gears” (Arrington & Logan, 2004), which carries switching costs in terms of time and attention (Arrington & Logan, 2004; Monsell, 2003; Rogers & Monsell, 1995). Second, we expected participants in the continual-switch condition to exhibit lower fluency precisely *because* their idea generation would be characterized by diminished fixation (i.e., higher adjacency dissimilarity). A long history of cognitive psychology research suggests that inter-item retrieval should be considerably slower for categorically different uses as compared to categorically similar uses (Meyer & Schvaneveldt, 1971; Neely, 1977). Thus, if participants in the continual-switch condition indeed exhibit higher adjacency dissimilarity as we predicted herein, they should also exhibit lower fluency.

## 2.1. Method

### 2.1.1. Participants and design

We recruited 126 native English speakers (46.8% female;  $M_{\text{age}} = 32.42$ ,  $SD_{\text{age}} = 10.73$ ) from Amazon Mechanical Turk (MTurk), an online crowdsourcing platform with subjects representative of the U.S. population (Buhrmester, Kwang, & Gosling, 2011). Participants qualified for the study only if they were located in the United States and had an approval rate above 98% for their previous “Human Intelligence Tasks” (HITs) on MTurk. Sixty-nine percent self-identified as White, 14.3% as Asian, 7.9% as Black, 4.8% as Hispanic, and the rest as Other. Eleven participants were excluded because they had participated in a study that employed the AUT, leaving 115 participants in the sample.

Upon consenting to the study, participants were randomly assigned to one of three experimental conditions: continual-switch, discretionary-switch, or midpoint-switch.

### 2.1.2. Materials and procedure

To familiarize participants with the AUT, we first had them complete a 2-min practice trial that involved listing creative uses for a cup (e.g., wear it as a hat). Next, participants had a total of 8 min to complete two experimental AUTs: listing creative uses for a brick and listing creative uses for a toothpick. These two tasks were pretested to be similar in difficulty. In the continual-switch condition, participants were instructed to list uses for the two objects in an alternating manner (i.e., brick, toothpick, brick, toothpick, etc.). In the discretionary-switch condition, participants were instructed to list uses for the two objects in any order they chose. In the midpoint-switch condition, participants were instructed to spend the first 4 min listing uses for one object and immediately the next 4 min for the other. In all three conditions, the two objects were counterbalanced such that half participants started with brick and the other half started with toothpick. The study was programmed with JavaScript such that once a participant moved on to listing the next use, he or she could not return to modify the previous use. Before beginning the two AUT tasks, all participants responded to an attention check question; no one failed to identify his or her randomly assigned condition.<sup>2</sup>

## 2.2. Results

### 2.2.1. Switching frequency

As predicted, participants in the continual-switch condition switched far more frequently ( $M = 17.89$ ,  $SD = 6.81$ ) than those in the discretionary-switch condition ( $M = 7.55$ ,  $SD = 2.81$ ),  $t(77) = 9.02$ ,  $p < 0.001$ ,  $d = 2.06$ , and those in the midpoint-switch condition (who, by definition, only switched once between the two AUTs;  $M = 1.00$ ,  $SD = 0.00$ ),  $t(71) = 14.89$ ,  $p < 0.001$ ,  $d = 3.53$ .

### 2.2.2. Creativity measures

Four trained, independent coders who were blind to the study predictions and experimental conditions coded the uses in four different ways: (1) flexibility, (2) novelty, (3) usefulness, and (4) fluency, each of which is described below. Table 1 details these metrics across the three conditions.

**2.2.2.1. Flexibility.** The flexibility of uses is commonly operationalized as the total number of unique usage categories (Kaufman & Sternberg, 2010). To tally the flexibility of the two objects ( $ICC_{\text{flexibility\_brick}} = 0.96$ ,  $ICC_{\text{flexibility\_toothpick}} = 0.96$ ), the coders employed categories used by Tadmor, Galinsky, and Maddux (2012) for brick (e.g., weapon) and similarly created a list of categories for toothpick (e.g., writing tool). Consistent with our prediction, the mean flexibility in the continual-switch condition ( $M = 15.57$ ,  $SD = 5.19$ ) was significantly higher than in the discretionary-switch condition ( $M = 13.35$ ,  $SD = 4.44$ ),  $t(77) = 2.05$ ,  $p = 0.04$ ,  $d = 0.47$ , and marginally higher than in the midpoint-switch condition ( $M = 13.74$ ,  $SD = 3.60$ ),  $t(71) = 1.75$ ,  $p = 0.08$ ,  $d = 0.41$ .

**2.2.2.2. Novelty.** Following past research (e.g., Silvia et al., 2008), we examined the novelty of each response in two complementary ways: subjective and objective novelty. We computed the subjective novelty score using the consensual assessment technique (Amabile, 1982), whereby the coders subjectively judged the novelty of each response (1 = *least novel*, 5 = *most novel*) based on their

<sup>2</sup> At the end of the study, we also measured five mood variables (i.e., “How frustrated/happy/agitated/smooth/difficult did you feel during the task?” on a five-point Likert scale: 1 = *not at all*, 5 = *extremely*). However, these are not the key measures of interest for the current research given the large literature on mood and creativity. Analyses revealed no significant difference in mood among the three experimental conditions (all  $p$ 's > 0.10). Moreover, the effect of task switching was not mediated by these mood variables, further justifying their exclusion in the results section.

**Table 1**  
Performance on the Alternative Uses Task by condition (Study 1).

	Condition		
	Continual Switch	Discretionary Switch	Midpoint Switch
Flexibility	15.57 <sub>a</sub> (5.19)	13.35 <sub>b</sub> (4.44)	13.74 <sub>b</sub> (3.60)
Subjective Novelty	1.80 <sub>a</sub> (0.28)	1.58 <sub>b</sub> (0.21)	1.57 <sub>b</sub> (0.31)
Objective Novelty	99.48% <sub>a</sub> (0.27%)	99.23% <sub>b</sub> (0.48%)	99.19% <sub>b</sub> (0.72%)
Usefulness	3.41 <sub>a</sub> (0.41)	3.28 <sub>a</sub> (0.45)	3.14 <sub>b</sub> (0.50)
Fluency	18.96 <sub>b</sub> (6.84)	23.52 <sub>a</sub> (12.27)	23.06 <sub>a</sub> (7.42)

Note. Values in parentheses are standard deviations. Within each row, means with different subscripts are significantly different by  $p < 0.05$  in a two-tailed  $t$  test.

“tacit, personal meanings” of novelty (Silvia et al., 2008). This technique of subjective scoring has been validated in a wide range of contexts and samples (Hennessey & Amabile, 2010). The interrater reliabilities for both objects were acceptable ( $ICC_{\text{subjective\_novelty\_brick}} = 0.80$ ,  $ICC_{\text{subjective\_novelty\_toothpick}} = 0.73$ ). We then computed the mean subjective novelty score across the two objects for each participant. As predicted, the mean subjective novelty rating was significantly higher ( $M = 1.80$ ,  $SD = 0.28$ ) in the continual-switch condition than in both the discretionary-switch condition ( $M = 1.58$ ,  $SD = 0.21$ ),  $t(77) = 4.11$ ,  $p < 0.001$ ,  $d = 0.89$ , and the midpoint-switch condition ( $M = 1.57$ ,  $SD = 0.31$ ),  $t(71) = 3.48$ ,  $p = 0.001$ ,  $d = 0.81$ .

To compare the novelty of uses listed under the three conditions in a more objective way, we also employed a measure called “output dominance” (i.e., the commonness of a response in the entire collection of responses; Kaufman & Sternberg, 2010). Specifically, we tallied the total number of times each use was generated across participants (e.g., “to pick a lock” was listed 19 times for toothpick) and divided that value by the total number of uses listed by all 115 participants for each object (e.g., the total number of uses listed for toothpick = 1262; the output dominance of “to pick a lock” =  $19/1262 = 1.51\%$ ). The higher the output dominance score, the less novel a listed use was. We computed an objective novelty score by subtracting the output dominant score from 1 (e.g., the objective novelty score of “to pick a lock” =  $1 - 1.51\% = 98.49\%$ ); thus, the higher the objective novelty score, the less common a use was listed by the sample population. For each participant, we computed the mean objective novelty score across his or her responses across the two objects. As predicted, the mean objective novelty score was significantly higher in the continual-switch condition ( $M = 99.48\%$ ,  $SD = 0.27\%$ ) than in both the discretionary-switch condition ( $M = 99.23\%$ ,  $SD = 0.48\%$ ),  $t(77) = 2.88$ ,  $p = 0.005$ ,  $d = 0.64$ , and the midpoint-switch condition ( $M = 99.19\%$ ,  $SD = 0.72\%$ ),  $t(71) = 2.29$ ,  $p = 0.025$ ,  $d = 0.54$ .

**2.2.2.3. Usefulness.** To test our proposition that continual task switching would enhance the generation of novel ideas that are *no less* useful, we used the consensual assessment technique (Amabile, 1982) to also assess the usefulness dimension of the AUT. Two coders subjectively judged the usefulness of each response (1 = *least useful*, 5 = *most useful*) based on their tacit, personal meanings of usefulness. The interrater reliability for both objects was acceptable ( $ICC_{\text{subjective\_usefulness\_brick}} = 0.74$ ,  $ICC_{\text{subjective\_usefulness\_toothpick}} = 0.79$ ). We computed the mean usefulness score across the two objects for each participant. Consistent with our prediction, the mean usefulness rating in the continual-switch condition ( $M = 3.41$ ,  $SD = 0.41$ ) was not significantly different from that in the discretionary-switch condition ( $M = 3.28$ ,  $SD = 0.45$ ),  $t(77) = 1.26$ ,  $p = 0.21$ ,  $d = 0.29$ . Interestingly, the mean usefulness rating in the continual-switch condition was

significantly higher than in the midpoint-switch condition ( $M = 3.14$ ,  $SD = 0.50$ ),  $t(71) = 2.43$ ,  $p = 0.018$ ,  $d = 0.58$ .<sup>3</sup>

**2.2.2.4. Fluency.** The coders also counted the fluency, or the total number of non-repeated uses a participant listed for each object (e.g., listing “use a toothpick to write in the sand” twice would only be counted once) ( $ICC_{\text{fluency\_brick}} = 0.99$ ,  $ICC_{\text{fluency\_toothpick}} = 0.99$ ). We then computed the total fluency of the two objects for each participant. As predicted, the total fluency was significantly lower in the continual-switch condition ( $M = 18.96$ ,  $SD = 6.84$ ) than in both the discretionary-switch condition ( $M = 23.52$ ,  $SD = 12.27$ ),  $t(77) = -2.07$ ,  $p = 0.042$ ,  $d = 0.46$ , and the midpoint-switch condition ( $M = 23.06$ ,  $SD = 7.42$ ),  $t(71) = -2.46$ ,  $p = 0.016$ ,  $d = 0.58$ .

**2.2.2.5. Adjacency dissimilarity (i.e., measure of fixation).** To measure cognitive fixation, we coded whether or not any two adjacent responses listed for a given object belonged to same usage category (0 = same category, 1 = different categories). For instance, if a participant listed “to write in the sand; to write on a wall; to scratch body; to poke a hole” for a toothpick, then the adjacency dissimilarity (AD) scores for this object would be 0, 1, and 1, respectively.<sup>4</sup> This provided a measure of whether a use listed for a given object in serial position  $K$  was functionally equivalent to the use listed for that object at serial position  $K-1$  (i.e., whether the participant “fixated” on a preceding response when generating a current response). We then computed the mean AD score across the two objects for each participant. Consistent with the theoretical argument that continual switching reduces fixation, the mean AD was significantly higher in the continual-switch condition ( $M = 0.95$ ,  $SD = 0.07$ ) than in both the discretionary-switch condition ( $M = 0.90$ ,  $SD = 0.10$ ),  $t(77) = 2.68$ ,  $p = 0.009$ ,  $d = 0.60$ , and the midpoint-switch condition ( $M = 0.87$ ,  $SD = 0.13$ ),  $t(71) = 3.07$ ,  $p = 0.003$ ,  $d = 0.73$ .

### 2.2.3. Mediation analyses

To investigate whether the more frequent switching in the continual-switch condition yielded higher creative performance by reducing cognitive fixation, we conducted bootstrapping analyses with 5000 iterations (Preacher & Hayes, 2008). Since there was no statistically significant difference in any of the creativity measures between the discretionary- and midpoint-switch conditions, we collapsed them into a single “discretionary/midpoint-switch” condition. As predicted, the number of switches significantly mediated the effect of the continual-switch condition (vs. the discretionary/midpoint-switch condition) on adjacency dissimilarity (bias-corrected 95% CI = [0.0201, 0.1065],  $p = 0.005$ ). In turn, adjacency dissimilarity mediated the effects of the continual-switch condition (vs. the discretionary/midpoint-switch condition) on flexibility (bias-corrected 95% CI<sub>flexibility</sub> = [0.2180, 1.3590],  $p = 0.004$ ), subjective novelty (bias-corrected 95% CI<sub>subjective novelty</sub> = [0.0084, 0.0688],  $p = 0.012$ ), and objective novelty (bias-corrected 95% CI<sub>objective novelty</sub> = [0.0010, 0.1204],  $p = 0.067$ ), but not on usefulness (bias-corrected 95% CI<sub>usefulness</sub> = [-0.1190, 0.0076],

<sup>3</sup> Although we predicted that continual switching would increase creative performance by enhancing the novelty but not the usefulness of participants’ responses, we also computed a composite score of overall creativity based on both novelty and usefulness in keeping with past work (e.g., Hoever, Van Knippenberg, van Ginkel, & Barkema, 2012; Zhou & Oldham, 2001). Specifically, we multiplied the subjective novelty score and the usefulness score for each participant. Results revealed that the mean composite creativity score was significantly higher in the continual-switch condition ( $M = 6.08$ ,  $SD = 0.89$ ) than in both the discretionary-switch condition ( $M = 5.16$ ,  $SD = 0.91$ ),  $t(77) = 4.54$ ,  $p < 0.001$ ,  $d = 1.04$ , and the midpoint-switch condition ( $M = 4.85$ ,  $SD = 0.83$ ),  $t(71) = 6.12$ ,  $p < 0.001$ ,  $d = 1.45$ .

<sup>4</sup> The first two responses belong to the same functional category (writing tool), so this pair would receive a score of 0. The second and the third responses belong to different functional categories (writing tool and scratching tool, respectively), receiving a score of 1. The third and fourth responses belong to different functional categories (scratching tool and piercing tool, respectively), thus receiving a score of 1.

$p = 0.11$ ). The same patterns of mediation emerged when comparing just the continual-switch and discretionary-switch conditions, or when comparing just the continual-switch and midpoint-switch conditions.

These results suggest that continual task switching yielded superior creative performance by reducing cognitive fixation, thereby elevating the novelty (rather than the usefulness) of the ideas generated.

### 2.3. Discussion

Confirming our predictions, results revealed that the continual-switch condition yielded more ideas that were categorically dissimilar (i.e., higher flexibility) and novel (i.e., greater subjective and objective novelty) than did the discretionary-switch and midpoint-switch conditions. Critically, the ideas generated in the continual-switch condition were rated as no less useful than those generated in the other two conditions. Between-condition mediation analyses provided evidence that higher frequency of switching resulted in higher adjacency dissimilarity (i.e., lower cognitive fixation), which in turn increased both the flexibility and novelty of creative responses. Consistent with the finding of Madjar and Shalley (2008), there was no significant difference between the discretionary-switch and midpoint-switch conditions in any of the divergent thinking measures.

## 3. Study 2. The effects of task switching on convergent thinking

Study 2 examined whether having people continually switch between convergent thinking tasks would enhance their performance, thereby testing whether the positive effects of continual task switching on divergent thinking would extend to the domain of convergent thinking. Just as individuals can be less creative on the AUT because they tend to fixate on the preceding responses, they may fail to identify the solution to a convergent thinking problem (e.g., Dunker's candle problem) because they fixate on strategies that should be abandoned. When faced with multiple convergent thinking tasks, persisting with one task may result in fixation on an ineffective strategy, whereas switching between them may enable the mind to approach each task with fresh angles. Thus, Study 2 examined whether instructing individuals to continually switch between two convergent thinking tasks would reduce fixation and increase the likelihood of solving them.

We randomly assigned participants to complete two convergent thinking tasks under one of the three conditions: continual-switch, discretionary-switch, or midpoint-switch. To test whether the effects of task switching are generalizable across different types of convergent thinking tasks, we used two Remote Associates Test (RAT) problems to examine the effects of task switching on verbal convergent thinking, and then used two insight puzzles to examine the effects of task switching on visual convergent thinking (Lu et al., in press; Sio & Ormerod, 2009). As in Study 1, we hypothesized that participants in the continual-switch condition would switch at a higher frequency and thus perform better on the convergent thinking tasks than their counterparts in the discretionary-switch or midpoint-switch condition.

### 3.1. Method

#### 3.1.1. Participants and design

One hundred and four native English speakers (62.5% female;  $M_{\text{age}} = 23.31$ ,  $SD_{\text{age}} = 5.95$ ) from a large northeastern university in the United States completed the lab experiment. Among them, 84% were current students, and the rest were university staff and alumni. 35.6% self-identified as White, 33.7% as Asian, 10.6% as

Black, 6.7% as Hispanic, and the rest as Other. Two participants were excluded because they did not attend to the tasks. For the analyses for insight puzzles, we further excluded eight participants because they indicated that they had seen one or both of the puzzles before (i.e.,  $N = 94$ ).

Participants were randomly assigned to one of three experimental conditions: continual-switch, discretionary-switch, or midpoint-switch. After consenting to the study, they completed a set of two RAT problems (Mednick, 1962) followed by a set of two insight problems. Each participant was in the same condition for both sets of paper-and-pencil problems.

#### 3.1.2. Materials and procedure

The experimenter remained in the room for the duration of the study to oversee the timing of the switches for participants in the continual- and midpoint-switch conditions or to record the number of the self-initiated switches for participants in the discretionary-switch condition.

In the first half of the study, the experimenter administered two RAT problems to assess verbal convergent thinking. Specifically, participants had a maximum of 4 min to solve two RAT problems pretested to be similar in difficulty (RAT1: cheese, blood, print [solution: blue]; RAT2: way, mission, let [solution: sub]). Each RAT required participants to identify a single word that was independently associated with each of three cue words. To ensure that participants understood the task, the experimenter adduced two RAT examples (Example 1: water, skate, cream [solution: ice]; Example 2: wall, clip, toilet [solution: paper]) before participants attempted the two experimental RATs.

In the continual-switch condition, the experimenter instructed participants to alternate between the two RATs by uttering "switch" every 30 s. That is, participants spent the first 30 s on the first RAT, then the next 30 s on the second RAT, then the next 30 s on the first RAT, and so forth. In the discretionary-switch condition, participants were free to work on the two RATs in whatever order they chose during the 4 min (e.g., the first 42 s on the first one, then the next 15 s on the second one, then the next 37 s on the first one, etc.); the experimenter recorded how many times participants switched. In the midpoint-switch condition, participants had two consecutive minutes to attempt the first RAT, and immediately after, another two consecutive minutes to attempt the second RAT. In all three conditions, once a participant correctly solved one RAT, he or she had the remaining time to work on the other. The order of the two RATs was counterbalanced across participants.

After the time allotted to the two RAT problems elapsed (i.e., 4 min), the experimenter administered two insight puzzles to assess visual convergent thinking in the second half of the study. Specifically, participants had a maximum of 12 min to solve the nine-dot puzzle and the coin puzzle (Kershaw & Ohlsson, 2004; Maier, 1930), which had been pretested to be similar in difficulty (Lu et al., in press). The nine-dot puzzle required participants to draw four straight lines that connect all the dots without lifting the pen off the paper (see Appendix A for solution); the coin puzzle required participants to move one coin to make two rows (in any direction) of four coins each (see Appendix B for solution).

In the continual-switch condition, the experimenter instructed the participants to alternate between the two puzzles by uttering "switch" every 90 s. In the discretionary-switch condition, participants were free to work on the two puzzles in whatever order they chose during the 12 min; the experimenter recorded how many times participants switched. In the midpoint-switch condition, participants had six consecutive minutes to solve the first puzzle and immediately after, another six consecutive minutes to solve the second puzzle. In all three conditions, once a participant correctly solved one insight puzzle, he or she had the remaining time

to work on the other insight puzzle. The order of the two puzzles was counterbalanced across participants such that half started with the nine-dot puzzle and the other half started with the coin puzzle.

## 3.2. Results

### 3.2.1. RATs

**3.2.1.1. Switching frequency.** As predicted, participants in the continual-switch condition switched significantly more frequently ( $M = 3.71$ ,  $SD = 1.84$ ) than both those in the discretionary-switch condition ( $M = 1.56$ ,  $SD = 0.91$ ),  $t(65) = 5.97$ ,  $p < 0.001$ ,  $d = 1.48$ , and those in the midpoint-switch condition (who, by definition, only switched once between the two RATs;  $M = 1.00$ ,  $SD = 0.00$ ),  $t(68) = 8.73$ ,  $p < 0.001$ ,  $d = 2.11$ .

**3.2.1.2. Likelihood of solving RATs.** Table 2 compares the percentage of participants who solved the RATs across the three conditions.

Participants in the continual-switch condition were significantly more likely to solve RAT1 than both those in the discretionary-switch condition,  $\chi^2(1, N = 67) = 4.19$ ,  $p = 0.041$ , and those in the midpoint-switch condition,  $\chi^2(1, N = 70) = 8.29$ ,  $p = 0.004$ , while there was no significant difference in RAT1 solution rate between the discretionary-switch and midpoint-switch conditions,  $\chi^2(1, N = 67) = 0.65$ ,  $p = 0.42$ . Similarly, participants in the continual-switch condition were significantly more likely to solve RAT2 than both those in the discretionary-switch condition,  $\chi^2(1, N = 67) = 6.49$ ,  $p = 0.011$ , and those in the midpoint-switch condition,  $\chi^2(1, N = 70) = 8.24$ ,  $p = 0.004$ , while there was no significant difference in RAT2 solution rate between the discretionary-switch and midpoint-switch conditions,  $\chi^2(1, N = 67) = 0.08$ ,  $p = 0.78$ .

Aggregately, participants in the continual-switch condition were more likely to solve *at least one* RAT than those in the discretionary-switch condition,  $\chi^2(1, N = 67) = 2.98$ ,  $p = 0.08$ , and those in the midpoint-switch condition,  $\chi^2(1, N = 70) = 8.74$ ,  $p = 0.003$ , while there was no significant difference between the discretionary-switch and midpoint-switch conditions,  $\chi^2(1, N = 67) = 1.58$ ,  $p = 0.21$ . Moreover, participants in the continual-switch condition were significantly more likely to solve *both* RATs than both those in the discretionary-switch condition,  $\chi^2(1, N = 67) = 11.49$ ,  $p = 0.001$ , and those in the midpoint-switch condition,  $\chi^2(1, N = 70) = 10.94$ ,  $p = 0.001$ , while there was no significant difference in the likelihood of solving both RATs between the discretionary-switch and midpoint-switch conditions,  $\chi^2(1, N = 67) = 0.05$ ,  $p = 0.83$ .

**3.2.1.3. Switching frequency and RAT performance within the discretionary-switch condition.** Further supporting our prediction that continual switching improves RAT performance, a logistic regression showed that among participants in the discretionary-switch condition, the number of discretionary switches positively predicted the odds of successfully solving both RATs ( $B = 1.59$ ,  $SE = 0.71$ ,  $Wald = 5.05$ ,  $p = 0.025$ ).

### 3.2.2. Insight puzzles

**3.2.2.1. Switching frequency.** On average, participants in the continual-switch condition switched more frequently ( $M = 5.03$ ,  $SD = 1.69$ ) than those in the discretionary-switch condition ( $M = 2.04$ ,  $SD = 1.17$ ),  $t(59) = 7.92$ ,  $p < 0.001$ ,  $d = 2.07$ , and those in the midpoint-switch condition (who, by definition, only switched once between the two insight puzzles;  $M = 1.00$ ,  $SD = 0.00$ ),  $t(64) = 13.73$ ,  $p < 0.001$ ,  $d = 3.43$ .

**Table 2**

Percentage of participants who solved RATs by condition (Study 2).

	Condition		
	Continual Switch	Discretionary Switch	Midpoint Switch
RAT1 solved	71.4% <sub>a</sub>	46.9% <sub>b</sub>	37.1% <sub>b</sub>
RAT2 solved	68.6% <sub>a</sub>	37.5% <sub>b</sub>	34.3% <sub>b</sub>
At least one RAT solved	88.6% <sub>a</sub>	71.9% <sub>a</sub>	57.1% <sub>b</sub>
Both RATs solved	51.4% <sub>a</sub>	12.5% <sub>b</sub>	14.3% <sub>b</sub>

Note. Within each row, means with different subscripts are significantly different by  $p < 0.05$  in a two-tailed  $t$  test.

**Table 3**

Percentage of participants who solved insight puzzles by condition (Study 2).

Metrics	Condition		
	Continual Switch	Discretionary Switch	Midpoint Switch
Nine-dot puzzle solved	42.4% <sub>a</sub>	14.3% <sub>b</sub>	18.2% <sub>b</sub>
Coin puzzle solved	48.5% <sub>a</sub>	25.0% <sub>a</sub>	15.2% <sub>b</sub>
At least one puzzle solved	75.8% <sub>a</sub>	32.1% <sub>b</sub>	30.3% <sub>b</sub>
Both puzzles solved	15.2% <sub>a</sub>	7.1% <sub>a</sub>	3.0% <sub>a</sub>

Note. Within each row, means with different subscripts are significantly different by  $p < 0.05$  in a two-tailed  $t$  test.

**3.2.2.2. Likelihood of solving insight puzzles.** Table 3 compares the percentage of participants who solved the insight puzzles across the three conditions.

Participants in the continual-switch condition were significantly more likely to solve the nine-dot puzzle than both those in the discretionary-switch condition,  $\chi^2(1, N = 61) = 5.77$ ,  $p = 0.016$ , and those in the midpoint-switch condition,  $\chi^2(1, N = 66) = 4.59$ ,  $p = 0.032$ , while there was no significant difference between the discretionary-switch and midpoint-switch conditions,  $\chi^2(1, N = 61) = 0.17$ ,  $p = 0.68$ . Similarly, participants in the continual-switch condition were marginally more likely to solve the coin puzzle than those in the discretionary-switch condition,  $\chi^2(1, N = 61) = 3.56$ ,  $p = 0.059$ , and significantly more likely than those in the midpoint-switch condition,  $\chi^2(1, N = 66) = 8.45$ ,  $p = 0.004$ , while there was no significant difference between the discretionary-switch and midpoint-switch conditions,  $\chi^2(1, N = 61) = 0.93$ ,  $p = 0.34$ .

Consistent with the RAT results, aggregately, participants in the continual-switch condition were significantly more likely to solve *at least one* insight puzzle than both those in the discretionary-switch condition,  $\chi^2(1, N = 61) = 11.68$ ,  $p = 0.001$ , and those in the midpoint-switch condition,  $\chi^2(1, N = 66) = 13.69$ ,  $p < 0.001$ , while there was no significant difference between the discretionary-switch and midpoint-switch conditions,  $\chi^2(1, N = 61) = 0.02$ ,  $p = 0.88$ .

**3.2.2.3. Switching frequency and puzzle performance within the discretionary-switch condition.** Further supporting our prediction that switching improves performance on the insight puzzles, a logistic regression revealed that among participants in the discretionary-switch condition, the number of discretionary switches positively predicted the odds of successfully solving *at least one* puzzle ( $B = 1.25$ ,  $SE = 0.58$ ,  $Wald = 4.69$ ,  $p = 0.030$ ).

## 3.3. Discussion

As predicted, participants in the continual-switch condition solved more RATs and insight puzzles than their counterparts in

the discretionary-switch and midpoint-switch conditions. These results indicate that just as continually putting one divergent thinking task aside for another enhances performance, so too does putting one convergent thinking task aside for another. The creative benefits of continual task switching were further corroborated by the finding that, within the discretionary-switch condition, participants who switched more frequently were more successful than those who switched less frequently. Importantly, participants in the discretionary-switch condition on average switched far less frequently than those in the continual-switch condition, suggesting that individuals tend to “under-switch” when left to their own discretion. Thus, encouraging individuals to switch more frequently than they ordinarily do may enhance their creative performance.

In sum, instructing people to continually switch between two divergent thinking tasks (Study 1) or between two convergent thinking tasks (Study 2) yielded higher creative performance than instructing people to switch at their own discretion or in a serial fashion. However, these findings raise important questions: Are people *already* cognizant of the creative benefits of continual task switching? Or do they underestimate their propensity for cognitive fixation and thus undervalue the creative benefits of fresh launching points during idea generation and creative problem solving? In other words, when incentivized to perform well, do people choose to work under the continual-switch condition rather than the other two (demonstrably suboptimal) conditions for divergent and convergent thinking tasks? Addressing these questions would underscore the value of Studies 1 and 2, particularly if people discount the creative benefits of the continual-switch condition and thus fail to choose it on their own. In the remaining four studies, we examine how people choose to structure their creative work when allowed to select the most advantageous work condition.

#### 4. Study 3a. How do people choose to approach divergent thinking tasks?

Study 1 found that continual task switching enhanced divergent thinking, in part because temporarily putting one task aside for another mitigated cognitive fixation. Study 3a sought to build on this finding by examining people's *expectations* about the work condition that would yield superior divergent thinking performance. Specifically, we incentivized participants to select the work condition that would maximize their performance on the AUT. We predicted that participants would discount the creative benefits afforded by the continual-switch condition and thus overwhelmingly opt for the other two conditions. Such a result would imply that people undervalue the creative benefits of task switching, such that when left to their own discretion, they are unlikely to switch at a sufficient frequency to capture the positive effects of continual switching on divergent thinking (as shown in Study 1).

##### 4.1. Method

###### 4.1.1. Participants

We recruited 101 participants (43.6% female;  $M_{\text{age}} = 31.28$ ,  $SD_{\text{age}} = 9.63$ ) from MTurk to complete the online study. As in Study 1, participants qualified for the study only if they were located in the United States and had an approval rate above 98% for their previous MTurk HITs. Fifteen of them indicated that they had previously participated in a study that employed the AUT; results were similar whether we included or excluded them.

###### 4.1.2. Materials and procedure

Participants were initially led to believe that they would have 8 min to list creative uses for two common objects: a brick and a

toothpick (i.e., the exact same experimental stimuli of Study 1). We explicated the differences among the three conditions (continual-switch, discretionary-switch, and midpoint-switch) and instructed participants to choose the condition under which they would “complete” the two tasks. To incentivize participants to choose the most effective work condition, we explained that performers in the top 10% would be entered into a drawing to earn \$40 of additional reward. In other words, we did not want participants to simply select a condition that they expected to enjoy the most or feel most comfortable with; instead, we wanted to ensure that they would select the condition that they believed would help them generate the most creative output. Right before choosing their work condition, participants predicted the effectiveness of the three conditions by ranking which condition would yield: (a) the greatest number of unique usage categories (i.e., flexibility), (b) the most novel uses (i.e., novelty), and (c) the greatest number of uses (i.e., fluency).<sup>5</sup> At the end of the study, we debriefed them, explaining that we were only interested in their predictions and that they would not actually complete the AUTs or be entered into a lottery.

##### 4.2. Results

A chi-square test of goodness-of-fit revealed that the three conditions were not equally selected,  $\chi^2(2, N = 101) = 25.09, p < 0.001$ . Specifically, far fewer participants chose to work under the continual-switch condition (9.9%) than the discretionary-switch condition (46.5%) or the midpoint-switch condition (43.6%). Omnibus Friedman tests demonstrated that the mean ranks (1 = *most favorable*, 3 = *least favorable*) of the three conditions were significantly different for predicted flexibility, novelty, and fluency (all  $p$ 's < 0.001). For each of the omnibus Friedman tests, we then conducted post hoc Wilcoxon signed-rank tests with a Bonferroni correction (i.e., adjusted significance level =  $0.05/3 = 0.017$ ). For all three measures, participants ranked the continual-switch condition as the least favorable (all  $p$ 's < 0.001) and the discretionary-switch and midpoint-switch conditions as equally favorable (all  $p$ 's > 0.05).

##### 4.3. Discussion

Despite the creative advantage of the continual-switch condition over the other two conditions (as shown in Study 1), the majority of participants predicted the continual-switch condition to be the least effective for divergent thinking and erroneously chose either the discretionary-switch or midpoint-switch condition to “complete” the AUTs. These results suggest that when individuals are free to structure divergent thinking tasks, they are unlikely to choose the more effective continual-switch approach and thus unlikely to capture its creative benefits.

#### 5. Studies 3b & 3c. How do people choose to approach convergent thinking tasks?

Study 2 found that continual task switching enhanced convergent thinking. Similar to Study 3a, Studies 3b and 3c aimed to examine people's expectations about the work condition that would yield the best convergent thinking performance. Specifically, we incentivized participants to select the work condition

<sup>5</sup> We also asked participants to predict which of the three conditions would be the most (a) frustrating, (b) smooth, (c) productive, and (d) enjoyable. However, as in Study 1, these are not the key measures of interest for the current research. Analyses revealed that participants ranked the continual-switch condition as the least favorable for all four variables (all  $p$ 's < 0.001) and the discretionary-switch and midpoint-switch conditions as equally favorable.

under which they would best perform on the two RAT problems and the two insight puzzles used in Study 2. We again predicted that participants would discount the creative value afforded by the continual-switch condition and thus overwhelmingly select the discretionary-switch or midpoint-switch condition. Such a result would imply that people hold erroneous expectations about the positive effect of task switching on convergent thinking, such that when left to their own discretion, they are unlikely to switch at a sufficient frequency (as shown in Study 2).

### 5.1. Study 3b method

#### 5.1.1. Participants and design

We recruited 101 MTurk participants (51.5% female;  $M_{\text{age}} = 31.91$ ,  $SD_{\text{age}} = 10.11$ ) to complete the online study. As in Study 3a, participants qualified for the study only if they were located in the United States and had an approval rate above 98% for their previous MTurk HITs.

#### 5.1.2. Materials and procedure

Participants were initially led to believe that they would have 4 min to attempt two RAT problems. They were told that once they solved one RAT, they would have the remaining time to work on the other. To explain the nature of the RATs, we adduced two examples (RAT1: cheese, blood, print [solution: blue]; RAT2: way, mission, let [solution: sub]), which were the exact same two RATs used as experimental stimuli in Study 2.

As in Study 3a, we explicated the differences among the three conditions (continual-switch, discretionary-switch, and midpoint-switch) and instructed participants to choose the condition under which they would “attempt” two new RATs. As in Study 3a, we incentivized participants to select the most effective work condition by informing them that performers in the top 10% would be entered into a drawing to earn \$20 of additional reward. Again, this was to ensure that participants would choose the most effective rather than the most enjoyable work condition. Right before choosing their work condition, participants predicted the effectiveness of the three conditions by ranking under which condition they would solve the most RATs.<sup>6</sup> At the end of the study, we debriefed them, explaining that we were only interested in their predictions and that they would not actually attempt the RATs or be entered into a lottery.

### 5.2. Study 3b results

A chi-square test of goodness-of-fit revealed that the three conditions were not equally selected,  $\chi^2(2, N = 101) = 53.78$ ,  $p < 0.001$ . Specifically, far fewer participants chose to work under the continual-switch condition (5.0%) than the discretionary-switch condition (64.4%) or the midpoint-switch condition (30.7%). An omnibus Friedman test demonstrated that the mean ranks of the three conditions were significantly different for the predicted number of RATs solved,  $\chi^2(2) = 61.01$ ,  $p < 0.001$ . Post-hoc Wilcoxon signed-rank tests with a Bonferroni correction (i.e., adjusted significance level =  $0.05/3 = 0.017$ ) revealed that participants ranked the continual-switch condition as the least favorable and the discretionary-switch condition as the most favorable (all  $p$ 's  $< 0.001$ ).

<sup>6</sup> We also asked participants to predict which of the three conditions would be the most (a) frustrating, (b) smooth, and (c) enjoyable. As aforementioned, these are not the key measures of interest for the current research. Analyses revealed that participants ranked the continual-switch condition as the least favorable and the discretionary-switch condition as the most favorable for all three variables (all  $p$ 's  $< 0.05$ ).

### 5.3. Study 3c method

#### 5.3.1. Participants and design

Similar to Study 3b, we recruited 101 MTurk participants (47.5% female;  $M_{\text{age}} = 30.93$ ,  $SD_{\text{age}} = 10.06$ ) to complete the online study. As in Studies 3a and 3b, participants qualified for the study only if they were located in the United States and had an approval rate above 98% for their previous MTurk HITs.

#### 5.3.2. Materials and procedure

Participants were initially led to believe that they would have 12 min to attempt two insight puzzles. They were told that once they solved one puzzle, they would have the remaining time to work on the other. To explain the nature of insight puzzles, we adduced the examples of the nine-dot puzzle and the coin puzzle, which were the exact same insight puzzles used as experimental stimuli in Study 2.

As in Studies 3a and 3b, we explicated the differences among the three conditions (continual-switch, discretionary-switch, and midpoint-switch) and instructed participants to choose the condition under which they would “attempt” two new puzzles. Consistent with Study 3b, we incentivized participants to choose the most effective condition by telling them that performers in the top 10% would be entered into a drawing to earn \$20 of additional reward. Right before choosing their work condition, participants predicted the effectiveness of the three conditions by ranking under which condition they would solve the most puzzles.<sup>7</sup> At the end of the study, we debriefed them, explaining that we were only interested in their predictions and that they would not actually attempt the puzzles or be entered into a lottery.

### 5.4. Study 3c results

A chi-square test of goodness-of-fit revealed that the three conditions were not equally preferred,  $\chi^2(2, N = 101) = 39.94$ ,  $p < 0.001$ . Specifically, far fewer participants chose to work under the continual-switch condition (4.0%) than the discretionary-switch condition (51.5%) or the midpoint-switch condition (44.5%). An omnibus Friedman test demonstrated that the mean ranks of the three conditions were significantly different for the predicted number of puzzles solved,  $\chi^2(2, N = 101) = 63.58$ ,  $p < 0.001$ . Post-hoc Wilcoxon signed-rank tests with a Bonferroni correction (i.e., adjusted significance level =  $0.05/3 = 0.017$ ) revealed that participants ranked the continual-switch condition as the least favorable and the discretionary-switch condition as the most favorable (all  $p$ 's  $< 0.001$ ).

### 5.5. Discussion

Consistent with Study 3a, the vast majority of participants in Studies 3b and 3c chose to “solve” the RATs and insight problems in either the discretionary-switch or midpoint-switch condition—in spite of the creative advantage of continual-switch condition over these two conditions (as demonstrated in Study 2). Moreover, most participants predicted the continual-switch condition to be the least effective for the convergent thinking tasks.

<sup>7</sup> We also asked participants to predict which of the three conditions would be the most (a) frustrating, (b) smooth, and (c) enjoyable. As aforementioned, these are not the key measures of interest for the current research. Analyses revealed that participants ranked the continual-switch condition as the least favorable and the discretionary-switch condition as the most favorable for all three variables (all  $p$ 's  $< 0.05$ ).

## 6. Study 3d. How do school leaders choose to approach creativity tasks?

To ascertain the robustness of the findings in Studies 3a–3c, we surveyed a different population—leaders of K-12 schools—to examine which task-switching condition they would choose if given the opportunity to solve creative puzzles.

### 6.1. Study 3d method

#### 6.1.1. Participants and design

Ninety-four K-12 school leaders (75.5% female;  $M_{\text{age}} = 32.03$ ,  $SD_{\text{age}} = 5.11$ ) attending a summer training institute run by a national charter school network volunteered to complete a one-question paper-and-pencil survey.

#### 6.1.2. Materials and procedure

We asked participants to imagine that they had been asked to solve two insight puzzles within 12 min. To explain the nature of insight puzzles, we adduced the same examples of the nine-dot puzzle and the coin puzzle used in Studies 2 and Study 3c. As in Study 3c, we explicated the differences among the three conditions (continual-switch, discretionary-switch, and midpoint-switch) and instructed participants to choose the condition under which they would perform the best. Importantly, we created six versions of the survey to counterbalance the presentation order of the three choice options.

### 6.2. Study 3d results and discussion

Consistent with Studies 3a–3c, a chi-square test of goodness-of-fit revealed that the three conditions were not equally preferred,  $\chi^2(2, N = 94) = 91.68, p < 0.001$ . As before, fewer participants chose the continual-switch condition (7.4%) than the discretionary-switch condition (79.8%) or the midpoint condition (12.8%). In other words, similar to the MTurk participants, education leaders also appear to discount the creative benefits of continual task switching.

## 7. General discussion

An existing body of evidence suggests that putting tasks aside improves creative performance by diminishing cognitive fixation. Breaks, distractions, interruptions—anything that leads people to temporarily set a task aside—may help them reset their thinking and approach creative problems with fresh angles. Building upon prior work, we have shown that directing individuals to continually switch between tasks can enhance creativity. Compared to participants who completed the two AUTs one after the other and participants who switched at their own discretion, participants who continually switched between two AUTs produced more flexible and novel ideas that were just as useful (Study 1). Likewise, participants who continually switched between two RATs or between two insight puzzles were more successful than participants who attempted the tasks one after the other or participants who switched at their own discretion (Study 2).

As evidence of the fixation-reducing effects of task switching, participants in the continual-switch condition were more likely to list a response that was unrelated to the preceding response than participants in the midpoint-switch or discretionary-switch condition (Study 1). Importantly, this reduced tendency to fixate on the preceding response significantly mediated the effects of the continual-switch condition on both flexibility and novelty, thereby providing mechanistic evidence for why task switching enhances creativity. Past research has struggled to directly

measure fixation to show that it accounts for poor performance (e.g., Durso et al., 1994). To our knowledge, we are among the first to devise a metric—adjacency dissimilarity—for assessing the extent to which an individual is cognitively fixating during the AUT, which is perhaps the most widely utilized divergent thinking task (e.g., Baird et al., 2012; Gino & Wiltermuth, 2014; Lu et al., *in press*; Tadmor et al., 2012). However, we note that although reduced fixation mediated the effect of continual task switching on creativity, it might not be the only mediator at play in our studies.

The reported findings are consistent with the recent work by Smith et al. (2015) in that they found similar effects of continual task switching on divergent thinking tasks. Yet there are several notable differences between our work and theirs, including the duration of task switching and the work conditions examined. Furthermore, whereas Smith et al. (2015) solely revealed the creative benefits of task switching on divergent thinking, we demonstrated that these benefits are applicable to both divergent and convergent thinking. Collectively, our findings and Smith et al.'s (2015) findings suggest that continually setting aside tasks facilitates creativity because breaks reduce cognitive fixation and help people restructure how they search for ideas and solutions, which is a necessary step for generating creative output. Future research could explore other psychological mechanisms through which task switching may affect creativity.

Given the creative benefits of continual task switching, it is important to understand how individuals tackle creative tasks when left to their own discretion. Critically, we provide evidence that for both divergent and convergent thinking tasks, people discount the creative efficacy of continual task switching, such that they overwhelmingly fail to select the condition that yields the best creative performance (i.e., the continual-switch condition; Studies 3a–3d). The assertion that people “under-switch” when performing multiple creativity tasks is also supported by the finding that people switch far less frequently when left to their own discretion compared with when they are directed to switch continually (Studies 1 & 2). Furthermore, among individuals who switch at their own discretion, those who switch more frequently tend to outperform those who switch less frequently (Study 2).

To date, task switching has been criticized for its downsides, such as increased susceptibility to error-making. Much media coverage has urged people to stop “multitasking” (e.g., Green, 2011; Hallowell, 2005; Kleiman, 2013; Tugent, 2008). However, we argue that a key benefit overlooked by researchers and practitioners is that task switching allows an individual to temporarily set aside Task A to work on Task B, thereby alleviating cognitive fixation. By empirically demonstrating the creative benefits of continual task switching, the present research is among the first to unveil a bright side of task switching. To be clear, we do not mean to suggest that this bright side outweighs its dark sides (e.g., increased distraction, error making, anxiety). Rather, we seek to present a more nuanced and balanced understanding of the effects of task switching.

The present findings have important practical implications because creativity is vital to the success of individuals and organizations. As aforementioned, numerous leaders report that they struggle to design work routines that foster creativity among employees. Here we provide one intervention to help individuals “switch on” their creativity when navigating multiple tasks within limited time frames. Moreover, our findings are particularly meaningful because most individuals (e.g., school leaders) erroneously expect continual task switching to be ineffective for creative performance and thus switch with insufficient frequency if uninformed of its creative benefits.

Since creativity is so critical to the contemporary workplace and employees increasingly need to tackle multiple tasks, it is important to further our understanding of the effects of task switching

on creativity. The present research is a helpful step in this direction, though our studies are subject to a few limitations that offer avenues for future research. One limitation of Studies 1 and 2 is that participants switched between two creative tasks that shared the same basic algorithms. That is, we did not examine the effects of continual switching on two creative tasks that are qualitatively different in nature. What if individuals had been instructed to continually switch between an AUT (divergent thinking) and an insight puzzle (convergent thinking)? Moreover, what if individuals were to switch between a creative task and a non-creative task? In daily work routines, a manager may need to switch between brainstorming (i.e., a creative task) and completing expense reimbursements (i.e., a logistical task). Since task switching alleviates cognitive fixation, we predict that the creative benefits of continual task switching would also apply to these scenarios. Such predictions await future empirical investigations.

A second, related limitation of the present studies is that while they reveal that continually switching between creative tasks can enhance performance, the optimal switching schedule remains unclear. In line with the finding that creativity is task-specific (Baer, 1998), we speculate that the optimal frequency of task switching for creative performance may be task-specific and dependent on factors such as task difficulty and people's familiarity with the tasks. While the rate of task switching was constant in the continual-switch condition of Study 2 (e.g., each participant alternated between the two insight puzzles every 90 s), accelerating the switching rate over time may be even more conducive to creative performance, because the participant will be already familiar with the task rules when she returns to a task. Future research might vary the interval length between switches to explore the optimal switching schedule.

Finally, for certain tasks, reducing cognitive fixation via task switching may decrease the creative benefits of cognitive persistence. According to the dual pathway to creativity model (Nijstad, De Dreu, Rietzschel, & Baas, 2010), there are two qualitatively different pathways to creative performance: the flexibility pathway and the persistence pathway. Whereas the flexibility pathway leads to creativity through “flexible switching among categories, approaches, and sets” (Nijstad et al., 2010, p. 43), the persistence pathway leads to creativity through “hard work, the systematic and effortful exploration of possibilities, and in-depth exploration of only a few categories or perspectives” (Nijstad et al., 2010, p. 44). While task switching can enhance creativity via the flexibility pathway (i.e., less cognitive fixation), sustained and focused effort can also improve creative performance (e.g., Lucas & Nordgren, 2015). During the process of task switching, there is often an inherent tradeoff between flexibility and persistence (Nijstad et al., 2010), such that more frequent task switching heightens flexibility but lowers persistence, and vice versa. Future studies should explore how to balance between the two pathways to achieve the optimal level of creative performance.

**8. Conclusion**

Despite the premium assigned to creativity in the 21st century workplace, organizational leaders often struggle to structure work routines that nurture creativity among employees. By uncovering a bright side of continual task switching, the present research offers a tangible way to help individuals “switch on” creativity when navigating multiple creative tasks.

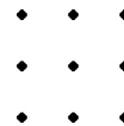
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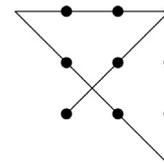
to Adam Galinsky, Freddy Gonzalez, Dan Mechanic, and Michael Morris and his lab group for their invaluable help and feedback. All study materials, data, and syntax have been uploaded to Open Science Framework: [https://osf.io/uqvb6/?view\\_only=fb86626d515f4eada54519287ec9cb23](https://osf.io/uqvb6/?view_only=fb86626d515f4eada54519287ec9cb23).

**Appendix A. Nine-dot puzzle**

Below are nine dots. Your challenge is to draw four straight lines that connect all of the dots without picking your pen off the paper. You can start from any position and draw the lines one after the other, but you can't lift your pen.

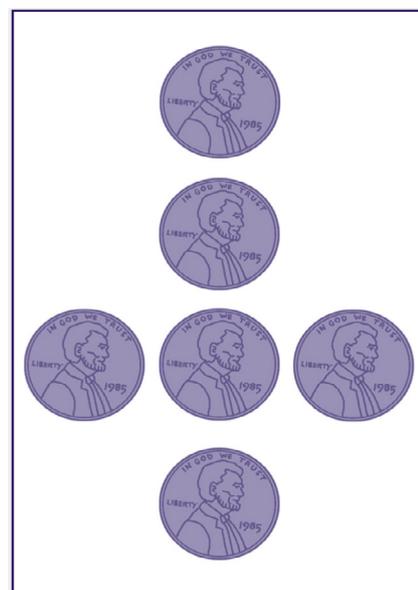


Solution:



**Appendix B. Coin puzzle**

How can you move only one coin to make two rows (in any direction) of four coins each?



Solution: Place the top coin on top of the coin in the middle.

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