Fixation, Flexibility, and Forgetting During Alternate Uses Tasks

Tim George and Jennifer Wiley
University of Illinois at Chicago

Divergent thinking tasks such as the alternate uses task (AUT) require overcoming dominant and common ideas, as well as ideas that are initially generated. The initial generation of familiar uses can create mental fixation, which makes it even more difficult to reach novel ideas. Manipulations that utilize task switching can sometimes help people break free from mental fixation. In the present studies, a new version of the AUT was created involving the generation of one use for each of 10 objects (multi-item), which was contrasted with the traditional construction in which people generated 10 uses for just one object (single-item). Across two experiments, a benefit of the multi-item task construction was observed. People were more flexible in the multi-item condition, the ideas they generated were more novel, and they arrived at novel ideas sooner. Additionally flexibility predicted novelty in the single-item but not the multi-item AUT. Participants were also prompted to recall their first idea following idea generation. Again, it was specifically in the single-item condition in which people who were more flexible were less likely to recall their first idea. This suggests that the multi-item AUT may reduce the difficulty associated with inhibiting old ideas and switching to new perspectives.

Keywords: divergent thinking, creativity, flexibility, inhibition

Creativity involves making novel connections across distantly related concepts, in a way that results in ideas that are novel and useful (Amabile, 1983). One important aspect of creativity is divergent thinking—the ability to generate many different possible ideas in response to open-ended prompts. In divergent thinking tasks, people are tasked with coming up with as many ideas as possible in response to a specific prompt. There are many challenges to generating creative ideas in these tasks. One such challenge comes from the need to overcome obvious ideas, dominant associations, or initial responses that readily come to mind when beginning the creative generation process. Activation arising from these sources can interfere with the ability to make connections to more interesting and unusual concepts that can serve as the basis for creative ideas. For instance, consider the alternate uses task (AUT; Guilford, 1957), a commonly used divergent thinking task in which the goal is to generate as many creative and unusual uses of common objects as possible, which deviate from the typical use. A person attempting to think of creative uses for a coffee mug may first think of using it as a pencil holder. This is a fairly commonplace use that does not diverge from the coffee mug’s central “container” function. Following this initial idea, other ideas related to “holding things” may still come to mind, such as holding spare change—another commonplace idea. In order to generate more novel ideas, it is necessary to shift attention considerably to overcome this holding function so that a less typical use can be considered (e.g., a makeshift minigolf hole). As a method of exploring creative cognition, the AUT is quite useful precisely because of the high chances of getting stuck or fixated, a common occurrence in real-world creative thinking experiences. It involves ordinary objects with a set of functions (including alternate, but still-common functions) to which we are well accustomed. Thus, some creative muscle is involved in moving beyond common ideas in order to arrive at more novel ideas.

This obstacle to creative output in divergent thinking (DT) tasks is not unlike the well-documented concept of mental fixation described in many problem-solving contexts. Duncker (1945) classic candle problem illustrates this concept nicely. In this task, participants were presented with a candle, a box of thumbtacks, and a book of matches with the task of securing the candle to a wall and lighting it without dripping wax on to the floor. The solution is to empty the box of tacks, use one of the tacks to fasten the now empty box to the wall, and then secure the candle inside the box and light it. However, arriving at this not-so-obvious solution requires that a person not remain fixated on the normal function of a box as just a container of other objects. As a consequence of this mental fixation, many participants were unable to change their representation of the box and produce the solution, and they instead attempted to solve the problem by tacking the candle directly to the wall.

Later work demonstrated the importance of overcoming fixation in the remote associates test (RAT; Mednick, 1962)—another commonly used creative-thinking task, in which three problem words (e.g., arm, tar, peach) are remotely linked to a single common solution (e.g., pit). Solving these problems is thought to rely on creative cognition because it involves linking distantly

Tim George and Jennifer Wiley, Department of Psychology, University of Illinois at Chicago.

Correspondence concerning this article should be addressed to Tim George, Department of Psychology, University of Illinois at Chicago, 1007 West Harrison Street (MC 285) Chicago, IL 60607. E-mail: tgeorg7@uic.edu
related concepts. For instance, performance on the RAT is hindered when each word in the problem set is presented along with highly related but misleading associates (e.g., arm-sleeve, tar-black, peach-tree; May, 1999; Smith & Blankenship, 1991). This also occurs when the misleading associates are studied prior to attempting the RAT problems (Smith & Blankenship, 1991; Storm & Angello, 2010). Wiley (1998) further demonstrated that performance is not only impaired by misleading information in the form of external stimuli, but from activation of one’s own prior background knowledge (e.g., baseball knowledge) that comes about from the RAT cue words. For instance, baseball experts were less likely than nonbaseball experts to solve the problem plate—broken—shot (answer: glass) due to their strong activation of the baseball-related meaning of plate that primed the misleading potential solution “home.” These results indicate that activation of misleading information during problem-solving attempts blocks access to more distant but relevant information.

While the RAT and Duncker’s candle problem represent convergent problem solving in which a single correct solution must be produced, a form of mental fixation can also take place in more open-ended DT tasks. The goal in these tasks is typically to produce original ideas. For instance, Jansson and Smith (1991) and Smith, Ward, and Schumacher (1993) used creative invention tasks (e.g., toy design) and found that exposing people to examples of ideas prior to generating their own creations tended to limit the scope of ideas produced. That is, people incorporated more features of the examples into their own ideas compared with people who viewed no examples. This increased use of example features also occurred when explicitly instructed to be as different as possible from the examples. Thus, it can be very difficult to break free from a focus on the most readily available information in memory so that more novel and distant ideas can be discovered.

In the AUT, constraints to creativity are likely to arise from previously known uses and obvious associates of the item, even in the absence of externally presented “fixating” information. Gilhooly, Fioratou, Anthony, and Wynn (2007) found that a dominant strategy in generating alternate uses is a memory retrieval strategy—participants’ initial ideas tend to be based on preknown uses that are easily retrieved from long-term memory, while later ideas tend to reflect other strategies. This result complements the finding of a serial-order effect in DT—ideas generated earlier in the task tend to be less creative than ideas generated later (Beaty & Silvia, 2012; Benedek et al., 2014; Kudrowitz & Dippo, 2013), and this is because it takes time and effort to overcome interference from obvious ideas. Both Beaty and Silvia as well as Gilhooly et al. (2007) argued that arriving at more original ideas requires inhibition of initially generated ideas and flexibly switching to new perspectives.

Flexibility in the context of DT tasks typically refers to the diversity of ideas produced in response to a prompt, often measured by the number of unique categories of ideas in a person’s response set. Such flexibility has been shown to positively relate to the novelty and creativity of ideas (De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012; Kudrowitz & Dippo, 2013; Nusbaum & Silvia, 2014; Runco, Millar, Acar, & Cramong, 2010). This is because being able to consider a variety of different categories or perspectives increases the likelihood of developing more novel ideas. Additionally, when flexibility is conceptualized as a more general cognitive ability (an individual difference), it also predicts creativity (Benedek, Könen, & Neubauer, 2012; Nusbaum & Silvia, 2011; Zabelina & Robinson, 2010).

Given the evidence of the importance of these factors in DT, what kinds of manipulations to DT tasks may help or hurt creative performance? One line of research builds on the finding that an incubation period—a break or interruption from problem solving attempts—can benefit creative problem solving more than continuous work on a problem (e.g., RAT problems; Haarmann, George, Smalyl, & Dienes, 2012; Smith & Blankenship, 1991). Several recent studies have now demonstrated that such an incubation period can benefit creative performance on DT tasks as well (Ellwood, Pallier, Snyder, & Gallate, 2009; Gilhooly, Georgiou, Garrison, Reston, & Sirotot, 2012; Hao, Liu, Ku, Hu, & Runco, 2015; Smith, Gerken, & Angello, 2017). One explanation for this benefit is that incubation periods provide a “fresh look” on the task—taking a break allows for the dissipation of inappropriate ideas created by an initial mental set.

For instance, in a series of experiments, Smith et al. (2017) tasked participants with generating novel instances of two categories (e.g., fattening foods, things you take camping) under two conditions: continuous or alternating. In the continuous condition, participants worked on generating instances for one category for 3 min before generating uses for the other category for 3 min. In the alternating condition, participants switched between the two categories every minute for 6 min. Participants in the alternating conditions generally produced a greater quantity of responses, and more novel responses than participants in the continuous conditions. Smith et al. (2017) argued that initial response attempts result in a biased retrieval set, wherein dominant or already-retrieved ideas block new ideas. Interrupting idea generation by alternating to another category allows for forgetting of the biased set, thereby facilitating retrieval of more novel ideas. However, because this was a category generation task that was not framed to participants as a creative exercise, it is not clear if such an effect would extend to more traditional DT tasks.

More recently, Lu, Akinola, and Mason (2017) found that alternating between two items in the AUT (brick, toothpick), which was framed as a creative exercise, enhanced the novelty and flexibility of responses compared to a condition involving continuous work on each of the items, or to a condition where participants were free to switch at their own discretion. In accordance with Smith et al. (2017), Lu et al. (2017) suggested that alternating between items helped mitigate the effects of mental fixation that occur in the more traditional, continuous work approach. In the absence of such task constructions, when working continuously on a single prompt in a DT task, such as the AUT, arriving at novel ideas requires participants to exercise flexibility (Benedek et al., 2012; Nusbaum & Silvia, 2011). People must abandon old ideas and approaches and choose new ones.

Forgetting may serve as one mechanism by which people overcome these obvious but noncreative ideas. Recent work (Storm & Patel, 2014), building on the framework of retrieval-induced forgetting (Anderson, Bjork, & Bjork, 1994), has found that forgetting of common uses results from attempting to think of creative alternate uses. Storm and Patel (2014) had participants study a list of four common uses of several objects. For half of these objects, participants then attempted to generate their own creative uses. In a later test of recall of all initially studied uses, participants showed greater forgetting of common uses following their own attempts at
idea generation. Additionally, the size of this forgetting effect was positively correlated with measures of creativity for the generated uses. Subsequently, Ditta and Storm (2017) also found that participants’ own initially generated ideas were subject to this forgetting effect. Participants tended to forget their first four ideas following a period of further idea generation more than if they had not attempted further idea generation. These results suggest that this forgetting is adaptive, and that it may reflect inhibitory processes that are utilized to reduce competition from dominant ideas during creative thinking, which results in subsequent diminished accessibility of those ideas (George & Wiley, 2016; Storm et al., 2015; Storm, Angello, & Bjork, 2011).

In sum, this body of research suggests that because divergent thinking tasks like the AUT typically require repeated attempts at generating ideas for the same item, this may make it difficult to overcome mental set created by initial idea attempts. Flexibly shifting to new categories and perspectives on the same prompt may present a challenge to creative idea generation. Alternate task constructions that do not require repeated generation of multiple responses for the same item might reduce some of the cognitive demands arising from the need to be flexible, and facilitate novel idea generation.

The present studies took the approach of Smith et al. (2017) and Lu et al. (2017), and tested how task structures that facilitate flexible switching may affect the efficiency of divergent thinking. Lu et al. (2017) specifically observed a benefit when participants switched back and forth between two items in the AUT. It is argued that the interruption of switching helps to break attention away from potentially fixating information created by continually thinking about an object, such that participants experience a fresh look when they return to the item following the switch. However, it is possible that not only switching back to a prompt helps creativity, but that switching across prompts also helps creativity? In the present experiments, a new version of the AUT was constructed that required generating just one creative use for each of 10 different objects (multi-item condition). This was contrasted with the more standard AUT, which in the present experiments involved generating 10 creative uses for one object (single-item condition).

Two alternative predictions can be made based on prior work. One the one hand, it has been shown that initial AUT ideas tend to be less original than later ideas (Beaty & Silvia, 2012; Kudrowitz & Dippo, 2013). Thus, in the multi-item condition, people may not have a “chance” to explore more creative ideas beyond their first (and only) idea for an item, and therefore novelty of ideas would suffer relative to the single-item condition. This makes the prediction that multiple attempts on a single item will be more beneficial for creative idea generation than single attempts on multiple items.

On the other hand, as in the Smith et al. (2017) and Lu et al. (2017) studies, because the multi-item condition involves regular switching within the task, it may have the benefit of reducing the fixating effects of a biased search set (Smith et al., 2017) that are inherent in divergent thinking about a single item. One possibility is that switching not only enables taking a fresh look at an item after obvious information associated with that item has dissipated, but that it also helps people to take on a fresh approach to generating alternate uses for subsequent items more generally. In the single-item condition, when attempting to think of ideas for a brick, for example, a person might initially generate obvious ideas and then attempt to switch to a new perspective. However, this can be difficult due to the mental set created by the output of initial ideas. In the single-item condition flexibility is very important, and people who demonstrate more switching between many categories or perspectives are more likely to arrive at novel ideas (De Dreu et al., 2012; Kudrowitz & Dippo, 2013; Nusbaum & Silvia, 2011; Runco et al., 2010). In contrast, in the multi-item condition, one is also likely to generate an obvious initial idea on the first item before then making an effort to think more creatively on additional tries. Further, upon presentation of new items this effort will not be as thwarted by previous ideas as in the single-item condition. This removal of interference from previous ideas may help people approach each subsequent use from a fresh perspective, and thus eliminate the need for spontaneous flexibility on the part of the participant. This makes the prediction that the single-item condition should be more difficult than the multi-item condition, which would result in slower idea generation. Correspondingly, the multi-item condition should result in the generation of more novel ideas than the single-item condition. Finally, flexibility should be correlated with novelty in the single-item condition but not the multi-item condition.

### Experiment 1

#### Method

**Participants.** University of Illinois at Chicago (UIC) students (*N = 100*) were recruited from the undergraduate introduction to psychology subject pool. Participants provided agreement to participate, and received course credit for participating. Half of the participants were randomly assigned to each condition. Lu et al. (2017) obtained an effect size of .81 (*d*) for the difference in novelty between a switching and continuous-work condition. Based on this effect size, in order to have 95% power to detect a difference, at least 41 participants in each condition were required. Additional participants were added to allow for counterbalancing of AUT objects.

**Materials.** Ten items were selected for the AUT: brick, paperclip, fork, pillow, belt, shoe, automobile tire, coffee mug, button, and plastic bag. For the single-item AUT, each item was used in equal numbers across participants. For the multi-item AUT, all 10 items were presented in a randomized order for each participant.

**Procedure.** Participants were instructed to generate creative uses for an item or items. Creative responses were defined as being typically: (a) uncommon, that is, not many other people think of them, (b) remote, that is, they stray from the obvious or typical use of that item, and (c) clever, that is, they are insightful, fitting, and appropriate. For the single-item AUT, participants were presented with only one of 10 items. Participants were instructed to press the space bar whenever a new idea came to mind and then type their idea into a response box, and the software recorded the response time for each idea (as indicated by the space bar press), as well as the typed response. For the multi-item AUT, participants were sequentially presented with the 10 items (a new item appeared after each response). In contrast to many other divergent thinking experiments, an advantage to this design is that it keeps fluency (the number of ideas generated) constant across conditions. In both
conditions, the response was removed from the screen after being entered by the participant. Participants had up to 10 min to generate their 10 responses. Because the tenth response was either not generated or lost due to program errors for 35 people (16 from multi and 19 from single), only the first 9 responses were analyzed for all participants. Additionally, response times were not logged for 1.6% of trials due to program errors.

**Scoring.** In order to score creativity, two raters who were blind to condition provided subjective ratings of novelty along a 1–5 scale (1 = not at all novel/uncommon; 5 = highly novel/uncommon) for each idea. Raters were instructed: “Creative ideas are often uncommon. Any idea you think would be likely to be given by a lot of people should be given a lower rating, while any idea likely to be given by only a few people should be given a higher rating.” Reliability between the two raters was good ICC(2) = .82.

In order to score flexibility, two raters provided subjective ratings of category switching. The raters viewed each participant’s set of responses in order and decided whether each subsequent response constituted a switch to a new category for that participant. Raters were instructed: “Flexibility, or switching, refers to how many different kinds of ideas a person produces, or how many distinct categories of ideas their responses span. A switch is when an idea seems like a shift in overall perspective from previous ideas, such that the new idea belongs in a different category than previous ideas.” Raters were instructed to mark each switch as a “1,” and otherwise to mark “0,” and that reverting to a category that the participant already used did not constitute a switch. All initial responses were categorized as a “switch,” and switch scores ranged from 1 to 9 for the 9 usable trials. Reliability between the two raters was good ICC(2) = .85. Participants did not make any repetitions of previous ideas.

**Results**

Participants took longer on average to come up with each idea in the single-item (\(M = 21.0 \text{ s}, SD = 9.9\text{s}\)) compared with the multi-item condition (\(M = 15.6 \text{ s}, SD = 6.7\text{s}; t(98) = 3.18, p < .01, d = .64\)). Further, the average novelty of ideas was also higher in the multi-item condition (\(M = 1.86, SD = .45\)) than the single-item condition (\(M = 1.64, SD = .31; t(98) = 2.82, p < .01, d = .57\)).

Participants in the multi-item condition generated more ideas flexibly (\(M = 8.30, SD = .76\)) than participants in the single-item condition (\(M = 5.62, SD = 1.35; t(98) = 12.20, p < .001, d = 2.46\)), which is not surprising given that each response was associated with a distinct item in the multi-item condition, and thus, will produce different kinds of ideas. However, flexibility was only significantly correlated with novelty in the single-item condition, \(r = .47, p < .01,\) and not in the multi-item condition, \(r = .00, p = .98.\)

**Discussion**

The results of this experiment suggest that generating one use for many items can decrease the difficulty and increase the novelty of ideas over generating many uses for a single item. The results also support the importance of flexibility in creative idea generation as switching to new approaches, perspectives, and categories increased idea novelty, as seen by the relation between flexibility and performance in the single-item condition. While thinking flexibly in divergent thinking tasks can be challenging because of the interference arising from initially generated ideas, the multi-item task construction may lessen this burden, and allow novel ideas to flow more readily. The multi-item task condition may have reduced the need for “spontaneous flexibility” (Guilford, 1957), as evidenced by the lack of relationship between flexibility and novelty in the multi-item AUT. These findings are in accord with those of Smith et al. (2017) and Lu et al. (2017) in that they demonstrate how prompting participants to switch among ideas within a divergent thinking task can benefit creativity. They extend these findings by showing that this benefit can occur even when repeatedly switching to new items, rather than just switching back and forth between two items.

One possibility is that participants in the multi-item condition were aware that they would only have one opportunity to generate an idea for each item, and therefore may have felt more pressure to censor themselves from entering obvious ideas rather than freely entering whatever ideas first came to mind. This could make them work harder toward producing creative ideas, which may have improved novelty. However, if it were the case that these participants took a more deliberative approach to the task, one would expect longer response times in the multi-item condition than single-item condition. Instead, the opposite pattern occurred, suggesting that the multi-item task construction increased the ease with which novel ideas were constructed.

**Experiment 2**

The goal of Experiment 2 was to replicate the beneficial effect of using multiple items on creativity, while additionally testing one potential source of this benefit. Specifically, one factor that may contribute to the difficulty in generating many uses for one item (i.e., single-item) is the need to inhibit already-generated ideas or response sets that tend to occur early in the creative process (Beaty & Silvia, 2012; Ditta & Storm, 2017). As discussed in Experiment 1, flexibly shifting to new approaches is important in creative idea generation, but this may be difficult in the face of interference from prior ideas, especially when repeatedly attempting to generate responses for the same prompt. In Experiment 2, participants first completed either the single-item or multi-item AUT, and upon completion of the task they were asked to recall the first idea they had thought of. Previous work has suggested that arriving at creative ideas in the AUT is aided by forgetting earlier ideas that would otherwise remain salient during subsequent attempts (Ditta & Storm, 2017; Storm & Patel, 2014), as reflected in impaired recall of those ideas later on. This forgetting effect may be a consequence of inhibitory mechanisms used during idea generation to help reduce competition from common ideas so that new approaches can be considered. One possibility is that the multi-item condition reduces the need to inhibit old ideas by reducing the competitiveness of previous ideas. Additionally, as discussed previously, flexibility is important for novelty. It may be that the effort required to flexibly shift to a new approach in the single-item condition involves inhibition of prior ideas. Thus, one should expect reduced recall (or more forgetting) for this initial idea in the single-item condition, relative to the multi-item condition. Additionally, if such a forgetting effect is at least partially tied to
inhibitory processing that aids idea generation, one might expect people who show more flexibility in their ideas to be more likely to forget their initial idea—especially in the single-item condition where the demands of overcoming initial ideas are greater.

Method

Participants. University of Illinois at Chicago (UIC) students (N = 100) were recruited from the undergraduate introduction to psychology subject pool. Participants provided agreement to participate and received course credit for participating. Half the participants were randomly assigned to each condition.

Materials. The materials were identical to those used in Experiment 1. As in Experiment 1, a number of individuals were missing data for Trial 10 (14 in single and 18 in multi). For consistency, only the first 9 trials were again analyzed. Again, response times failed to log for approximately 1.6% of trials due to program errors.

Procedure. The procedure was identical to that of Experiment 1, except that following the idea generation phase, participants were prompted to recall the first response that they had generated. Participants were provided 10 s to type this response.

Results

As in Experiment 1, participants took longer on average to come up with each idea in the single-item condition (M = 23.3 s, SD = 12 s) compared with the multi-item condition (M = 17.4 s, SD = 7.9 s; t(98) = 2.91, p < .01, d = .58). Participants in the multi-item condition also produced ideas that were more novel (M = 1.84, SD = .46) than the single-item condition (M = 1.67, SD = .35; t(98) = 2.02, p < .05, d = .42). Once again, flexibility was higher in the multiple-item condition (M = 8.44, SD = .76) than in the single-item condition (M = 5.72, SD = 1.14; t(98) = 14.00, p < .001, d = 2.36).

As for the relationship between flexibility and novelty in each condition, similar patterns were seen as in Experiment 1. Flexibility significantly correlated with novelty in the single-item condition, r = .41, p < .01, but not the multi-item condition, r = −.13, p = .38. Recall rates of first responses were also assessed. Participants were marginally more likely to forget their first response in the single-item condition (M = 48% correct recall) than the multi-item condition (M = 66% correct recall), χ^2(1) = 3.31, p = .07. More importantly, a binary logistic regression demonstrated that forgetting played a very different role in the two conditions. In order to test for the predicted relation between flexibility and forgetting that should theoretically be more likely in the single-item condition, flexibility, condition and the Flexibility × Condition interaction were entered as predictors in a binary logistic regression with recall likelihood as the outcome variable. As shown in Table 1, flexibility emerged as a significant predictor of recall likelihood such that people who were more flexible were generally more likely to forget (i.e., less likely to recall) their first idea. However, there was also a Flexibility × Condition interaction. Flexibility negatively predicted recall likelihood (i.e., positively predicted forgetting) in the single-item condition, e^(β) = .56, p < .05, but not in the multi-item condition, e^(β) = 2.00, p = .09.

Thus, these results generally support the prediction that attempting to think of novel ideas in the single-item condition is more effortful. The finding that flexibility predicted forgetting of the first response in the single-item condition specifically suggests that the attempt of shifting to new approaches requires people to reduce the accessibility of initial ideas.

Supplemental Analyses

The main results of both studies demonstrated that the multi-item condition led to more novel responses on an AUT than a single-item condition. In some respects, this result is surprising because it has been shown that ideas that are initially generated in response to AUT prompts tend to be less original than later ideas (Beaty & Silvia, 2012; Kudrowitz & Dippo, 2013). Given that the multi-item condition only provided an opportunity for individuals to generate an initial response for each item, it was possible that it could have led to worse performance overall. However, this was clearly not the case for the multi-item condition.

A final set of analyses (using the combined data from across the two studies) tested whether the predicted relation between serial position and idea novelty might still be observed in the single-item condition. As shown in Figure 1, across both conditions later ideas did tend to be more novel than earlier ideas. However, averaging idea novelty across participants for each serial position, there was a significant correlation between serial position and idea novelty, r = .87, p < .01. Additionally, the average intra-individual correlation between serial position and average idea novelty was higher in the single-item condition (M = .14), than in the multi-item condition (M = .02). A comparison of the novelty of first responses in the single-item and multi-item conditions also confirmed that people in both conditions started off with ideas of similarly low novelty, n(198) = 1.31, p = .19. As shown in Figure 1, although the multi-item condition maintained an overall advantage, in later idea positions, the single-item condition eventually approached the novelty level of the multi-item condition.

Additionally, an examination of response times averaged across participants at each serial position showed that there was a positive relation with order in the single-item condition, r = .83, p < .01, but a negative relation in the multi-item condition, r = −.76, p < .05. As shown in Figure 2, this indicates that the generation of additional ideas in the single-item condition became more and
Discussion

The results from Experiment 2 replicated the finding that generating a use for multiple different items in the AUT benefits idea novelty compared with generating multiple ideas for a single item. These results are conceptually consistent with the findings of Smith et al. (2017) and Lu et al. (2017). Additionally, the results demonstrate that subsequent forgetting of initial ideas is more likely to occur in the single-item condition than the multi-item condition. This reduced recall is likely the outcome of many factors—for example, in the single-item condition, people may experience more general interference in attempting to recall the first response. This is because many responses are associated with a single cue word, which makes recalling any one response more difficult than in the multi-item condition where each response is associated with a distinct cue word. However, the additional finding that flexibility of responding predicted forgetting in the single-item condition but not the multi-item condition suggests that forgetting may partially be a result of inhibitory mechanisms during idea generation. There is a greater need to be flexible in the single-item condition, and flexible thinking may involve inhibition of old, competing ideas. A byproduct of this effortful attempt to think of new ideas may be forgetting of initial ideas.

Finally, the examination of serial position of ideas was consistent with prior findings that ideas tend to get more novel over time (Beaty & Silvia, 2012; Benedek et al., 2014; Kudrowitz & Dippo, 2013). This examination also suggests that the multi-item condition allowed for novel ideas to be reached sooner.

General Discussion

As in other forms of creative problem solving, there is potential for mental fixation in divergent thinking tasks. Obstacles to creativity arise in the form of prior common associations, and initially generated ideas. In some sense fixation may be an inherent property of divergent thinking tasks such as the AUT. The task is to generate several different uses with the goal of being as creative as possible, but because uses must be generated in response to a single prompt, repeated generation of new ideas can be impeded by a biased set of initial ideas (Smith et al., 2017). It can take time and effort to overcome these obvious ideas (Beaty & Silvia, 2012). Manipulations that help reduce the influence of these initial ideas, such as incubation periods or task switches, can help to promote creative thinking (Ellwood et al., 2009; Gilhooly et al., 2012; Haarmann et al., 2012; Hao et al., 2015; Lu et al., 2017; Smith & Blankenship, 1991; Smith et al., 2017). In the present studies, a version of the AUT in which people generated one use for each of multiple objects improved idea novelty compared with the standard AUT task construction in which people generated multiple ideas for one object. Although this finding is somewhat surprising given that the first ideas generated for an object tend to be the least creative, this is consistent with previous findings that switching between two items can be beneficial to creativity (Lu et al., 2017; Smith et al., 2017). However, it goes beyond those previous
studies by finding an advantage for switching to new items, and not just due to returning to prior items over and over again. This means the benefit of the multi-item condition cannot simply be explained by switching allowing for the dissipation of obvious ideas that might be associated with a particular object, or due to incubation, because only one response per object was permitted. Rather, switching to new objects seemed to incur a benefit at a more general level, wherein switching across multiple prompts helps people to approach the task in a more adaptive way.

Several possible mechanisms may support this benefit. One such possibility is that people in the multi-item condition used their prior responses to help generate more novel ideas. For instance, people may have strategically used the category of a response for a previous object, where the category may be typical for the previous object but novel for another object. In general, this possibility is not supported because this would predict a negative relationship between flexibility (i.e., amount of switching to new categories) and novelty, and no such relationship was observed. Although it is possible that some participants used such a strategy, in general the data do not support this suggestion. Additionally, the coding of the extent to which participants built novel responses off of old responses indicated that participants in the multi-item condition were less likely to do this than those in the single-item condition. This is consistent with the notion that it tends to be more difficult for people to break out of mental set in the single-item condition, and is inconsistent with the idea that the multi-item benefit stems from novel responses being directly inspired from previously generated responses.

How does idea production differ in the single-item and multi-item conditions? In order to further expound on these mechanisms, it is important to turn attention to the observed serial order effects. The examination of idea novelty across time in the single-item condition was consistent with previous findings of serial order effects in divergent thinking (Beaty & Silvia, 2012; Benedek et al., 2014; Kudrowitz & Dippo, 2013), wherein novelty generally increased over time. Participants in both conditions started off with ideas of relatively low novelty. However, interestingly, the multi-item condition seems to have allowed people to generate novel ideas earlier than in the single-item condition. This is similar to the memory phenomenon of release from proactive interference (Wickens, Born, & Allen, 1963) wherein interference from initial ideas is stronger. While the difficulty in divergent thinking tasks, namely overcoming earlier ideas. This is similar to the memory phenomenon of release from proactive interference (Wickens, Born, & Allen, 1963) wherein interference from initial ideas is stronger. While the multi-item task construction builds in switches to new items, competition from previous ideas and associations may be reduced, and inhibition of old ideas may not be as necessary. With each switch to a new item, participants are able to take a fresh approach to generating creative uses, without being as thwarted by prior ideas and associations as they are in the single-item condition. The examination of idea quality across time helps to support this suggestion—participants in both conditions started off with ideas of low novelty; however, the multi-item condition seems to have allowed people to generate novel ideas earlier than in the single-item AUT. Thus, these experiments highlight one source of the difficulty in divergent thinking tasks, namely overcoming earlier ideas. This is similar to the memory phenomenon of release from proactive interference (Wickens, Born, & Allen, 1963) wherein interference from previously learned information is reduced when switching to new categories, resulting in improved performance. Other related mechanisms may also support the multi-item advantage. For example, switching to new items may induce an inner context shift that makes it easier to direct attention to more remote ideas (Smith, 1995).

One potential limitation of these studies is that the number of responses that each participant provided was fixed in order to keep fluency constant. In many other divergent thinking experiments, participants are given no limit on how many ideas they can produce, and differences are often seen in fluency metrics. Future work needs to explore how a multi-item generation condition would affect fluency, as well as how it might play out over longer durations. It is also important to address how task instructions may influence these findings. In the current studies, participants were not explicitly instructed to respond with flexibility. Perhaps encouraging participants to produce ideas from as many categories as possible in the single-item condition would make them perform more in line with the multi-item participants (i.e., by encouraging self-produced switching). It would also be worthwhile to further explore other types of task switches that may improve novelty.
given that prior work has shown benefits of unrelated task breaks on creative thinking (Sio & Ormerod, 2009).

Future work should also explore whether similar benefits of multi-item constructions are seen for other divergent thinking tasks. The AUT presents a situation where familiar ideas are very salient, and much of the creative difficulty stems from this. Benefits of switching may not be as strong for tasks where initial ideas are not as constrained by common and familiar associations (George, Wiley, Koppel, & Storm, 2017; Goldenberg, 2016).

In summary, these experiments indicate that getting past common ideas is difficult in the AUT, and that generating one use for each of multiple items can help reduce this difficulty and improve idea novelty by reducing the effects of mental fixation that occur more readily in the standard AUT. The results suggest that constructing novel ideas requires flexibly shifting to new approaches, and this involves overcoming initial ideas. From an applied perspective, this may suggest that alternating between tasks, rather than continued work on one task, may sometimes be beneficial for creative production.

References


Storm, B. C., Angel, G., & Bjork, E. L. (2011). Thinking can cause forgetting: Memory dynamics in creative problem solving. *Journal of...


Received August 9, 2017
Revision received December 7, 2017
Accepted February 7, 2018