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Inspired by Distraction: Mind Wandering Facilitates Creative Incubation

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Abstract

Although anecdotes that creative thoughts often arise when one is engaged in an unrelated train of thought date back thousands of years, empirical research has not yet investigated this potentially critical source of inspiration. We used an incubation paradigm to assess whether performance on validated creativity problems (the Unusual Uses Task, or UUT) can be facilitated by engaging in either a demanding task or an undemanding task that maximizes mind wandering. Compared with engaging in a demanding task, rest, or no break, engaging in an undemanding task during an incubation period led to substantial improvements in performance on previously encountered problems. Critically, the context that improved performance after the incubation period was associated with higher levels of mind wandering but not with a greater number of explicitly directed thoughts about the UUT. These data suggest that engaging in simple external tasks that allow the mind to wander may facilitate creative problem solving.

Keywords

creativity, consciousness, insight

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Anecdotes of individuals solving problems after relinquishing the effort to solve them date back millennia. Indeed, many influential scientific thinkers—including Newton, Poincaré, and Einstein—claim to have had their moments of inspiration while engaged in thoughts or activities not deliberately aimed at solving the problem they were trying to solve. A key question that arises from such examples is whether engaging in any type of unrelated cognition increases the frequency of creative solutions, or whether the thoughts that yield such insights have specific features.

One common example of thinking that is unrelated to an overt goal is the internally generated thought that occupies one's attention during mind wandering (Smallwood & Schooler, 2006). Several lines of research suggest that mind wandering could be linked to enhanced creativity, particularly for problems that have been previously encountered. First, individuals with attention-deficit/hyperactivity disorder (which is known to be associated with mind wandering; e.g., Shaw & Giambra, 1993) tend to score higher than individuals without ADHD on laboratory measures of creativity (White & Shah, 2006) and on questionnaire-based assessments of achievement in creative areas (e.g., music, visual arts; White & Shah, 2011).

Second, focused deliberation on problems can undermine creativity, whereas distraction can enhance creativity (Dijksterhuis & Meurs, 2006). Third, a recent meta-analysis of the conditions that maximize incubation effects (i.e., enhanced creative problem solving following a break) found that the benefits of incubation intervals are greater when individuals are occupied by an undemanding task than when they engage in either a demanding task or no task at all (Sio & Ormerod, 2009). Given that mind wandering is more frequent in undemanding tasks than in demanding tasks (e.g., Mason et al., 2007; Smallwood, Nind, & O'Connor, 2009), this finding suggests that one feature that may characterize successful incubation intervals could be the opportunity for mind wandering.

Finally, a recent investigation found that when individuals engaged in REM sleep during an incubation interval, they showed enhanced integration of unassociated information in the service of creative problem solving (Cai, Mednick,

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Harrison, Kanady, & Mednick, 2009). Although REM sleep is very different from mind wandering, the fact that the formation of associative networks during dreaming can lead to incubation effects is certainly consistent with the prospect that the loose associative processes of mind wandering (e.g., Smallwood, Obonsawin, & Heim, 2003) might have similar effects.

However, caution must be taken in drawing firm conclusions from the results of these studies; to date, no published study has directly compared the effects of incubation intervals of systematically varying difficulty within a single experiment, nor has any study directly assessed the occurrence of mind wandering during incubation. Furthermore, there are at least two competing interpretations of the beneficial effects of tasks with a light cognitive load: Easy tasks may simply allow individuals a greater opportunity to explicitly think about previous problems, or easy tasks may encourage a global mental set (e.g., Förster, Friedman, & Liberman, 2004) that might facilitate creativity independently of any specific benefit of incubation.

The study reported here used an incubation paradigm to compare the effects of interpolated tasks that systematically varied in their levels of attentional demand and thus in their conduciveness to mind wandering. The tasks were interpolated into the Unusual Uses Task (UUT), a classic and widely used measure of divergent thinking (Guilford, 1967). The UUT was selected because it yields particularly consistent and robust incubation effects (Ellwood, Pallier, Snyder, & Gallate, 2009; Sio & Ormerod, 2009), unlike convergent-thinking tasks (such as the Remote Associates Task), which have been more prone to empirical inconsistencies (Vul & Pashler, 2007). The UUT requires participants to generate as many unusual uses as possible for a common object, such as a brick, in a set amount of time. The originality of the responses is taken as an index of creative thinking (e.g., Milgram & Milgram, 1976; Torrance, 2008; Wallach & Kogan, 1965).

Following the procedure in Cai et al. (2009), we assessed participants' performance on UUT problems that were presented both before and after the incubation interval (*repeated exposure*) and on UUT problems that were presented for the first time after the incubation interval (*new exposure*). These exposure conditions allowed us to distinguish between two different types of improvements in problem solving: incubation effects (repeated-exposure condition), which correspond to enhanced processing of previously encountered information, and general increases in creative problem solving (new-exposure condition), which could correspond to general improvements in creative thinking or to other general facilitative effects (e.g., arousal or fatigue).

We had four hypotheses for this study. First, we expected that participants would exhibit more mind wandering in an interpolated undemanding task than in an interpolated demanding task, which would replicate previous findings that attentional demand reduces mind wandering (Smallwood et al., 2009). Given these anticipated differences in mind wandering, we hypothesized, second, that the creative benefits of incubation would be greater for participants who engaged in the undemanding task than for participants who engaged in the demanding task and, third, that this effect would not be attributable to a greater number of explicit thoughts about the previously encountered problems. Finally, we hypothesized that performance would selectively improve on repeated-exposure problems (i.e., not on new problems) following the undemanding task, which would indicate that the performance improvements resulted from an incubation process rather than a general increase in creative problem solving.

Method

Participants

One hundred forty-five participants (35 males, 110 females) completed the experiment (age range: 19–32 years) as partial fulfillment of a course requirement. Informed consent was obtained from all participants, and ethical approval for the study was obtained from the University of California, Santa Barbara, institutional review board.

Procedure

Baseline UUT. Participants were randomly assigned to work on two UUT problems (2 min per problem) in which they were instructed to list as many unusual uses as possible for each stimulus. Participants typed their responses on a computer, directly into a text box that automatically expired after 2 min.

Incubation. After completing the baseline UUT, participants were assigned to one of four between-subjects conditions, using a counterbalanced design. In three of these conditions (*demanding task, undemanding task*, and *rest*), the baseline UUT was followed by an incubation period that lasted 12 min. Participants in the demanding-task condition performed a 1-back working memory task that places a strong constraint on top-down attention, whereas those in the undemanding-task condition performed a choice reaction time task (0-back) requiring infrequent responses. Studies have shown that tasks without a working memory load elicit more mind wandering than tasks with a working memory load (e.g., Smallwood et al., 2009). In the rest condition, participants were asked to sit quietly during the incubation interval. Participants in the fourth condition (*no break*) did not receive a break from the UUT.

Immediately following the incubation interval in the demanding-task, undemanding-task, and rest conditions, we administered a commonly used self-report measure of mind wandering (e.g., Barron, Riby, Greer, & Smallwood, 2011; Matthews et al., 1999) in order to confirm differences in mind-wandering frequency between the two task conditions. (The questionnaire was administered following the rest interval in the rest condition in order to maintain consistency across incubation conditions.) This questionnaire asks participants to rate how often they engaged in different types of task-unrelated thought, such as considering personal worries or future or past events (rating scale from 1 to 5, with higher scores indicating higher levels of mind wandering). To assess explicit thoughts about the creativity task, we had participants in these three conditions complete a separate questionnaire on the frequency of their thoughts about the creativity problems during the incubation interval.

Postincubation UUT. After the incubation interval (or following the baseline UUT, in the case of the no-break condition), participants were informed that they would work on the UUT again. Four UUT problems (2 min per problem) were presented in a random order: two repeat problems (repeated-exposure condition) that were identical to the problems presented at baseline and two randomly assigned new problems (new-exposure condition).

Assessing propensity to mind-wander. At the end of the experiment, all participants completed the Daydreaming Frequency subscale of the Imaginal Process Inventory (IPI), which assesses individuals' general propensity to mind-wander (Singer & Antrobus, 1972).

Tasks

Interpolated tasks. Stimuli for the demanding and undemanding tasks were the digits from 1 through 9, which were presented serially (in quasirandom order) in the center of a computer screen for 1,000 ms each; each digit was followed by a 1,500-ms fixation cross. In both of these tasks, nontargets were black numbers that required no response, and nontargets occurred frequently, whereas targets were infrequent. In the undemanding task, targets were colored numbers, and participants had to determine whether each target stimulus was even or odd. In the demanding task, targets were colored question marks, and participants had to determine whether the stimulus immediately preceding each target was even or odd. Participants in both conditions received a short practice session with feedback.

UUT. Following the procedure used by Wallach and Kogan (1965), we pooled responses to each UUT stimulus across the sample, and points were assigned for statistically unique responses.[1] Percentage improvement on the UUT was calculated separately for each problem type (repeated exposure, new exposure) and was compared across conditions (undemanding task, demanding task, rest, no break). This was calculated as [(postincubation UUT score – baseline UUT score)/(baseline UUT score)] × 100 (see Cai et al., 2009, for a similar analytic method). Percentage improvement was calculated at the individual level and then averaged for each condition.

Although uniqueness scoring is the most standard method of scoring divergent-thinking tasks (e.g., Milgram & Milgram, 1976; Torrance, 2008; Wallach & Kogan, 1965), it has been criticized (Silvia et al., 2008) on the grounds that it may confound creativity with fluency (e.g., participants may receive high creativity scores simply by virtue of generating a large number of responses). Therefore, to assess fluency, we had two independent raters blind to condition tabulate the number of nonredundant responses each participant generated for each UUT stimulus. The interrater classification of nonredundant responses was highly reliable ($\alpha = .95$). For each individual, the two raters' scores were averaged to yield a measure of fluency.

Results

Mind wandering

Participants in the undemanding-task condition reported significantly greater mind wandering ($M = 2.47$, $SD = 0.66$) in the retrospective questionnaire than did participants in the demanding-task condition ($M = 2.15$, $SD = 0.67$), $F(1, 72) = 4.04$, $p < .05$, $\eta^2 = .05$. This result replicates previous findings that working memory load decreases the frequency of mind wandering.[2] An analysis of the demanding-task, undemanding-task, and rest conditions revealed no group differences in participants' retrospective reports about the degree to which they had been explicitly thinking about the previous creativity task, $F(2, 106) = 0.09$, $p = .90$, $\eta^2 = .002$.

Incubation-task performance measures

No significant difference in accuracy was observed between the undemanding task ($M = .87$, $SD = .10$) and the demanding task ($M = .88$, $SD = .20$), $F(1, 72) = 0.06$, $p = .80$, $\eta^2 = .001$. Response time to targets was significantly faster in the demanding task ($M = 518.39$ ms, $SD = 117.55$ ms) than in the undemanding task ($M = 648.97$ ms, $SD = 48.21$ ms), $F(1, 72) = 38.93$, $p < .001$, $\eta^2 = .35$. Faster response times were expected in the demanding task because responses were based on the previous (already-encoded) digit, whereas the undemanding task required participants to first encode the target digit and then respond. This difference in response times reflects the key difference in the structure of the two tasks: The demanding task required that the identity of nontarget stimuli be encoded, whereas the undemanding task did not require that participants attend to nontarget stimuli.

UUT uniqueness scores

We first analyzed the UUT uniqueness scores using a mixed-model analysis of variance (ANOVA) with exposure condition (repeated exposure, new exposure) as a repeated measures factor and incubation condition (undemanding task, demanding task, rest, no break) as a between-subjects factor. An Exposure Condition × Incubation Condition interaction emerged, $F(1, 141) = 4.98$, $p < .01$, $\eta^2 = .10$. To further explore this effect, we used univariate ANOVAs to analyze incubation-condition differences in repeated-exposure and new-exposure UUT uniqueness scores.

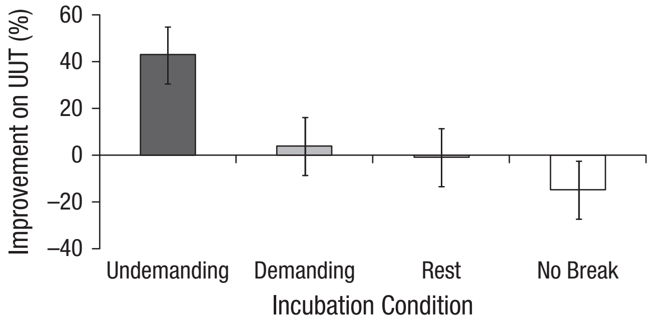

Fig. 1. Improvement in Unusual Uses Task (UUT) uniqueness scores (postincubation performance relative to baseline performance) for repeated-exposure problems as a function of incubation condition. Error bars indicate standard errors of the mean.

Repeated-exposure condition. There was a significant effect of incubation condition in the repeated-exposure condition, $F(1, 144) = 4.99$, $p < .01$, $\eta^2 = .10$. Participants who engaged in an undemanding task during the incubation interval displayed significantly greater improvement in UUT uniqueness scores for repeated-exposure problems compared with participants who engaged in a demanding task ($p < .01$), a period of rest ($p < .01$), or no break ($p < .01$). No significant difference in improvement was observed between participants who received no break and those who engaged in either a demanding task ($p = .35$) or a period of rest ($p = .30$); thus, no incubation effect was observed in the latter two conditions (see Fig. 1).

New-exposure condition. No incubation-condition differences were observed for improvement in uniqueness scores for new problems, $F(1, 144) = 1.01$, $p = .39$, $\eta^2 = .02$ (Fig. 2). No significant difference was observed between participants who received no break and those who engaged in an undemanding task ($p = .21$), a demanding task ($p = .70$), or rest ($p = .95$). Thus, there was no significant incubation effect in any incubation condition for the new-exposure problems.

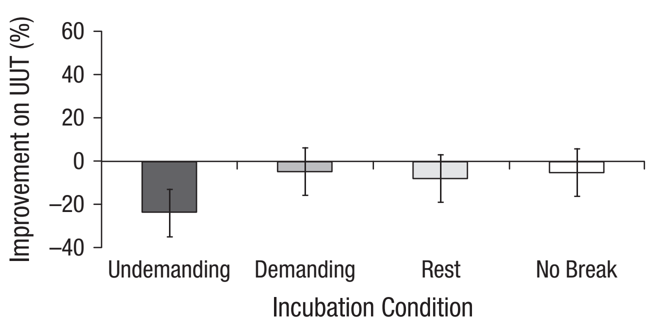

Fig. 2. Improvement in Unusual Uses Task (UUT) uniqueness scores (postincubation performance relative to baseline performance) for new-exposure problems as a function of incubation condition. Error bars indicate standard errors of the mean.

UUT fluency

Fluency scores for the repeated-exposure problems did not differ significantly between incubation conditions, $F(1, 144) = 1.15$, $p = .39$, $\eta^2 = .02$. This result rules out the possibility that between-condition differences in creativity as indexed by uniqueness scores were a result of confounding fluency and creativity.

Individual differences in mind wandering and UUT uniqueness scores

Scores on the Daydreaming Frequency subscale of the IPI positively correlated with UUT uniqueness scores for both repeated-exposure problems, $r = .22$, $p < .05$, and new-exposure problems, $r = .20$, $p < .05$. This result provides preliminary evidence that individuals who mind-wander more frequently in their daily lives may be more creative in general.

Discussion

Although research has suggested that taking a break can facilitate creativity, the mechanism of this incubation effect has remained unclear and has been the source of considerable empirical research and theoretical debate (e.g., Dijksterhuis & Meurs, 2006; Smith & Blankenship, 1989; Yaniv & Meyer, 1987). The study reported here demonstrated that taking a break involving an undemanding task improved performance on a classic creativity task (the UUT) far more than did taking a break involving a demanding task, resting, or taking no break. Notably, this improvement was observed only for repeated-exposure problems, which demonstrates that it resulted from an incubation process rather than a general increase in creative problem solving. Together, these data corroborate, within a single experiment, the conclusion of a recent meta-analysis (Sio & Ormerod, 2009) showing that incubation effects were larger in studies in which individuals engaged in an undemanding interpolated task than in studies that included a demanding interpolated task or a rest period.

Our data support the notion that specific types of unrelated thought facilitate creative problem solving. Even though the act of encoding information in working memory was unrelated to the solutions of the creativity problems, no incubation effect was observed in the demanding-task condition. Moreover, the undemanding-task condition was not associated with increased frequency of thoughts explicitly about the creativity problems, but was characterized by high levels of mind wandering. Thus, our data indicate that creative problem solutions may be facilitated specifically by simple external tasks (i.e., tasks not related to the primary task) that maximize mind wandering.

The observation that performance selectively improved for repeated-exposure problems (and not for new problems) indicates that engaging in a task conducive to mind wandering does not lead to general increases in creative problem-solving ability. However, performance on both repeated-exposure and new problems positively correlated with individuals' general propensity to mind-wander in everyday life (as assessed by the IPI). This observation provides preliminary evidence that there may be a relationship between individual differences in mind wandering and creativity. Although this observation is intriguing, it should be noted that this study lacked assessments for a variety of other individual differences measures (most notably, measures of inhibition) that could in principle account for the association between propensity to mind-wander and performance on the creativity task. An important direction for future research will be to conduct a more thorough assessment of the relationship between individual differences in mind wandering and creativity while controlling for other factors that could contribute to this relationship.

Further research is needed to determine precisely why the unrelated thoughts that occur during mind wandering uniquely facilitate incubation. One possibility is that mind wandering enhances creativity by increasing unconscious associative processing, as predicted by the spreading-activation account of incubation (e.g., Yaniv & Meyer, 1987; see also Dijksterhuis & Meurs, 2006). A second possibility derives from recent neuroimaging work indicating that executive and default networks interact during mind wandering (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009). Interactions between these networks are observed relatively rarely in cognitive neuroscience (although see Baird, Smallwood, & Schooler, 2011; Gerlach, Spreng, Gilmore, & Schacter, 2011); considering that activations in both networks are observed prior to successful solution of insight problems (Kounios et al., 2008; Kounios et al., 2006), engaging in tasks conducive to mind wandering could contribute to incubation by creating a situation in which default and executive systems mutually contribute to associative processing. Neurocognitive investigations of the brain activations that occur during successful incubation intervals might profitably explore this issue.

Anecdotal accounts of the inception of creative ideas have long implicated mind wandering in the creative process. The findings reported here provide arguably the most direct evidence to date that conditions that favor mind wandering also enhance creativity. From a theoretical perspective, this research also helps to establish at least one benefit from engaging in this otherwise seemingly dysfunctional mental state. Although mind wandering may be linked to compromised performance on an external task (Barron et al., 2011; McVay & Kane, 2009) and may be a signature of unhappiness (Killingsworth & Gilbert, 2010), it may also serve as a foundation for creative inspiration.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Notes

1. Following the procedure used by Wallach and Kogan (1965), we categorically assigned statistically unique responses a score of 1. Because problems were repeated in our incubation design, responses appearing up to two times across the sample received points. An alternative scoring method using a graded scale (from 1 to 5; S. Fiore, personal communication, January 25, 2011) yielded nearly identical results.

2. As noted, we also administered the mind-wandering questionnaire following the rest interval. The score on the retrospective mind-wandering scale in the rest condition ($M = 2.35$, $SD = 0.57$) was not significantly different from the score on this scale in either the undemanding-task condition ($p = .44$) or the demanding-task condition ($p = .19$), although this comparison is difficult to interpret because the rest condition included no primary task to which internal thoughts could fail to pertain.

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