Research Article

The Merits of Unconscious Thought in Creativity

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ABSTRACT—*Research has yielded weak empirical support for the idea that creative solutions may be discovered through unconscious thought, despite anecdotes to this effect. To understand this gap, we examined the effect of unconscious thought on two outcomes of a remote-association test (RAT): implicit accessibility and conscious reporting of answers. In Experiment 1, which used very difficult RAT items, a short period of unconscious thought (i.e., participants were distracted while holding the goal of solving the RAT items) increased the accessibility of RAT answers, but did not increase the number of correct answers compared with an equal duration of conscious thought or mere distraction. In Experiment 2, which used moderately difficult RAT items, unconscious thought led to a similar level of accessibility, but fewer correct answers, compared with conscious thought. These findings confirm and extend unconscious-thought theory by demonstrating that processes that increase the mental activation of correct solutions do not necessarily lead them into consciousness.*

The ability to associate remotely connected elements underlies many discoveries and creations in fields such as physics, mathematics, and art. Poincaré, for instance, noted that "to create consists of making new combinations of associative elements which are useful . . . . the most fertile will often be those formed of elements drawn from domains which are far apart" (Poincaré, 1913, p. 386). Other work has shown a more explicit connection between associative processes and creativity and considered the former the basis for creative output. For example, learning multiple languages or living abroad increases the number of associations between ideas, stimulating creativity (Leung, Maddux, Galinsky, & Chiu, 2008; Nemeth & Kwan, 1987; Simonton, 1999). Despite the significance of these associative processes, however, their nature has not been sufficiently understood.

One remarkable aspect of associative processes is that they do not seem to excel under conscious guidance. In fact, conscious thought can subvert the search for creative solutions, and novel connections or ideas often insinuate themselves into the conscious mind when conscious attention is directed elsewhere (Ghiselin, 1952; Mednick, 1962; Olton, 1979). Poincaré described this very phenomenon:

> I turned my attention to the study of some arithmetical questions apparently without much success and without a suspicion of any connection with my preceding researches. Disgusted with my failure, I went to spend a few days at the seaside, and thought of something else. One morning, walking on the bluff, the idea came to me . . . that the arithmetic transformations of indeterminate ternary quadratic forms were identical to those of non-Euclidean geometry (quoted in Hadamard, 1945, pp. 13–14).

Systematic examination of the effects of temporary inattention or incubation on associative search for creative solutions, however, has yielded weak and inconsistent findings (Olton, 1979), and researchers have concluded that incubation plays a secondary role in associative processes. The *forgetting-fixation* or *mental set-shifting* hypothesis, for example, suggests that correct solutions are often made inaccessible during initial problem solving because incorrect solutions are mistakenly retrieved. Thus, temporary distraction reduces associations with incorrect solutions, allowing correct ones to surface (Schooler & Melcher, 1995; Smith & Blankenship, 1989). Indeed, creativity is often hampered by existing knowledge structures, salient exemplars, and recently activated constructs (Kray, Galinsky, & Wong, 2006; Ward, 1994). Thus, there may be no inherent relationship between incubation and creativity; any factors that reduce associations with incorrect solutions should improve creative output.

Recently, however, Dijksterhuis and Meurs (2006) found that unconscious thought (i.e., being distracted while still holding a task-relevant goal) increased the generation of novel ideas more

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than an equal duration of conscious attention to the task. This finding suggested that temporarily distracting attention away from the task of generating ideas allowed participants to conduct broader searches that were less constrained by conventional associations. Unlike previous researchers, Dijksterhuis and his colleagues attributed the change in associative search patterns and increased creativity to something intrinsic to the absence of attention during unconscious thought. According to their unconscious-thought theory, conscious thought is adept at analytic and derivative processing that primarily isolates and discriminates, but unconscious thought excels at integrating and associating information and is capable of carrying out associative searches across a broad range of background knowledge (Dijksterhuis & Nordgren, 2006). When Dijksterhuis and Meurs asked participants to generate new names for products, participants who were distracted for a number of minutes generated more names that diverged from the examples given than did participants who consciously thought about the task for an equal duration, even though the two groups did not differ in the total number of names they generated. Unconscious thought appeared to change the very nature of the search process.

If this is true, however, why is there a paucity of empirical support for the incubation effect? To shed light on this gap, we introduce a distinction between thought process and outcome, proposing that incubation in the context of creativity and problem solving should be conceptualized as a two-step process. First, unconscious thought associates and creates the novel idea or solution to a problem; second, this solution is transferred to consciousness. A failure of either step would lead to the absence of empirical support for incubation. It is important to realize that the two steps can, and should, be separated. The idea that activation of solutions to creative problems could occur at different levels of consciousness is not new. Wegner and Smart (1997) drew a similar distinction in their discussion of deep cognitive activation. In their model, a thought or answer is fully activated if it is both conscious and accessible, but deeply activated if it is accessible but not currently conscious. In one study, for example, after unsuccessful attempts to solve insight problems, individuals displayed shorter latency in responding to solution-related words than in responding to solution-unrelated words when these words were presented to the right visual field (Bowden & Beeman, 1998).

We propose that unconscious thought may indeed be better at associative search than conscious thought is (Dijksterhuis & Meurs, 2006; Dijksterhuis & Nordgren, 2006), but the products of unconscious thought may not always be immediately entered into consciousness. Instead, they may remain unconscious, emerging into consciousness as insight at a later time (Maier, 1931) or eventually dissipating. Alternatively, they may surface as tacit cognitive or affective recognition of patterns, coherences, or themes. For example, when presented with coherent but incomplete stimuli (e.g., an incomplete drawing of a camel), participants were able to recognize the existence of some coherence at a rate better than chance, but could not always articulate what the stimuli represented (Bowers, Regehr, Balthazard, & Parker, 1990). We suggest that this feeling of "something is there" may be a partial manifestation of unconscious generation.

Thus, the absence of the incubation effect in creative problem solving does not necessarily imply an absence of creative activity. Researchers may have been looking for the incubation effect in the wrong place. In the current research, we differentiated conscious and unconscious manifestations of creative thought by examining two separate outcomes of the remote-association test (RAT; Mednick, 1962): implicit accessibility of correct RAT answers versus expression of those correct answers (Wegner & Smart, 1997). The RAT was originally developed as a test of creativity and has been widely used to study insight and creative thinking (e.g., Bowden & Beeman, 1998; Bowers et al., 1990; Schooler & Melcher, 1995). Each RAT problem consists of three words (e.g., *cheese-sky-ocean*), and participants generate a fourth word that, when combined with each of the three stimulus words, results in a word pair used in everyday language (e.g., *blue cheese*, *blue sky*, *blue ocean*). RAT problems are ideal for investigating our two-stage model because previous research has shown that accessibility of RAT answers does not always correlate with conscious production of those answers (Beeman & Bowden, 2000; Bowden & Beeman, 1998). Thus, we predicted that unconscious thought about RAT answers would increase their mental accessibility (relative to conscious thought about the answers), but that this increased deep activation might not translate into expression of the correct answers.

Because Bos, Dijksterhuis, and van Baaren (2008) found that unconscious thought improved problem solving only when participants expected to solve the problems following the distraction, we included a third condition (a mere-distraction condition) in which people were distracted just as in the unconscious-thought condition, but did not have a problem-solving goal. We expected that the unconscious would be less active when this goal was not present, and thus that correct RAT answers would be less accessible in this condition than in the unconscious-thought condition.

EXPERIMENT 1

Method

Participants and Design

The participants were 94 undergraduate students (43 male, 51 female; median age = 21 years). The experiment used a 3 (processing style: conscious thought vs. unconscious thought vs. mere distraction) × 2 (target words: RAT answers vs. control words) mixed factorial design, with the former being the between-participants factor.

Materials and Procedure

All instructions and materials were delivered via a computer. Participants were randomly assigned to one of the three conditions. In the conscious-thought and unconscious-thought conditions, participants were told, "The goal in this experiment is to find a word that is somehow linked to all three of the words (a triad) presented on each screen." In the mere-distraction condition, they were told, "The goal is to think about a word that is somehow linked to all three of the words (a triad) presented on each screen." Thus, participants in the mere-distraction condition were not given any explicit goal of problem solving. Participants then read two examples of RAT items before they started the task (e.g., the words *round*, *manners*, and *tennis* were linked by the word *table* in the pairs *round table*, *table manners*, and *table tennis*).

The RAT task included nine triads (selected from Bowden & Jung-Beeman, 2003) that are extremely difficult (see Table 1). (Pretesting involving 39 participants found that all but one of these triads had a solution rate lower than 20%; Bowden & Jung-Beeman, 2003). Each triad was presented on the center of the screen for 5 s; triads were separated by 3-s breaks. After participants had seen the ninth triad, a screen containing all triads was shown for 10 s. Afterward, participants in the conscious-thought condition were told that they had 5 min to think about these triads; during this time, they were shown the screen containing all triads, but were not allowed to write down notes or answers. Participants in the unconscious-thought condition were told that they would engage in an unrelated task before returning to the word task. Those in the distraction condition were told that they had finished the task and would move on to unrelated tasks. Participants in the unconscious-thought and mere-distraction conditions next completed a 2-back task for 5 min. This task consumes considerable working memory (Jonides et al., 1997) and was included to prevent conscious thought about the RAT items (Dijksterhuis, 2004). During this task, participants saw a sequence of numbers at the center of the screen and decided whether each matched the number that had been presented two numbers previously in the sequence.

TABLE 1

Triads Used in the Remote-Association Test in Experiment 1

Triad			Answer
stick	maker	point	match
trip	house	goal	field
fork	dark	man	pitch
line	fruit	drunk	punch
mate	shoes	total	running
land	hand	house	farm
hungry	order	belt	money
forward	flush	razor	straight
cast	side	jump	broad

Note. All triads in this experiment were very difficult to solve.

After 5 min of conscious thought or distraction on the 2-back task, all participants engaged in a lexical decision task (Bargh, Raymond, Pryor, & Strack, 1995). Strings of letters appeared on the center of the screen, and participants indicated whether or not each string constituted an English word by pressing one of two buttons. The assignment of responses to buttons was counterbalanced across participants. The letter strings included the RAT answers plus control words (four unrelated words and five nonwords), presented in a random order. Participants were given a short practice session consisting of six trials to acquaint them with the task.

After completing the lexical decision task, participants in all three conditions were again shown the RAT items and were asked to report their answers.

Results and Discussion

Correct RAT Answers

As expected, participants had considerable difficulty resolving the RAT items; across the conditions, participants correctly solved less than 17% of the triads, on average. Moreover, there were no differences between conditions, $F(2, 91) = 0.72$, $p = .49$, $p_{rep} = .51$. The number of correct solutions in the unconscious-thought condition ($M = 1.18$, $SD = 1.31$) did not differ from the number correct in the conscious-thought ($M = 1.61$, $SD = 1.60$) and mere-distraction ($M = 1.45$, $SD = 1.68$) conditions.

Response Latencies

We excluded response latencies more than 1,000 ms and less than 300 ms (Bargh et al., 1995) before submitting the data to a 3 (processing style: conscious thought vs. unconscious thought vs. mere distraction) × 2 (target words: RAT answers vs. control words) mixed analysis of variance. There was a significant two-way interaction, $F(2, 91) = 3.42$, $p = .037$, $p_{rep} = .90$ (see Fig. 1). As expected, participants in the unconscious-thought condition exhibited shorter response latencies and hence greater accessibility of RAT answers than did participants in the conscious-thought and mere-distraction conditions, $t(91) = -1.99$, $p = .049$, $p_{rep} = .88$. However, their response latencies to control words were not different from those in the other two conditions, $t(91) = -0.029$, $p = .98$, $p_{rep} = .07$. This pattern persisted even after excluding response latencies to RAT answers that participants later generated correctly: Response latencies for the RAT answers were still lower in the unconscious-thought condition than in the other two conditions, $t(91) = -1.72$, $p = .089$, $p_{rep} = .83$.

Across the three conditions, the correlation between response latencies for the answers and the number of correct answers produced was not significant ($r = -.041$, $p = .70$, $p_{rep} = .36$). This suggests that implicitly accessible RAT answers do not automatically emerge into the conscious mind as correct answers. However, restriction of range due to the low numbers of

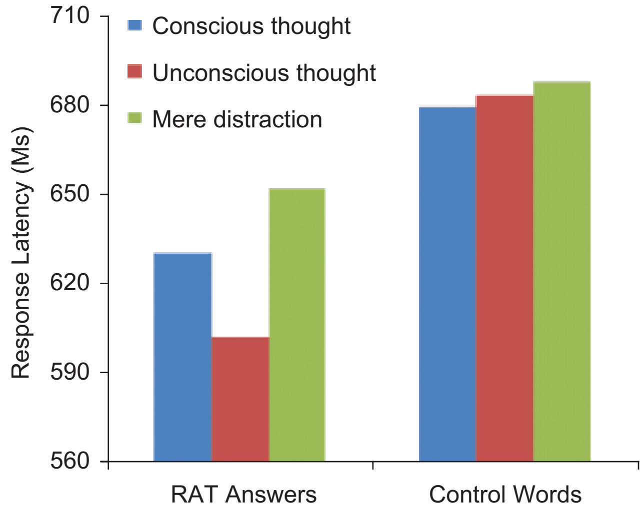

Fig. 1. Response latencies (in milliseconds) on the lexical decision task in the three conditions of Experiment 1. Results are shown separately for words that were correct answers on the preceding remote-association test (RAT) and for control words.

correct answers may have prevented meaningful correlations from emerging.

Discussion

Analysis of the conscious report of RAT answers replicated the lack of a meaningful incubation effect: A period of incubation, compared with the same duration of conscious concentration, did not increase the reporting of correct answers. The results on accessibility, however, revealed a striking difference: Unconscious thought, compared with conscious thought and mere distraction, increased the mental accessibility of RAT answers. Because the conscious- and unconscious-thought conditions did not differ in the number of correct answers reported, the increased accessibility of RAT answers following unconscious thought can best be attributed to differences between thought processes. These results are consistent with unconscious-thought theory, which systematically differentiates conscious and unconscious thought processes, and suggest that unconscious processing is more adept at associating and integrating information than conscious processing is (Dijksterhuis & Nordgren, 2006). Moreover, the level of activation of RAT answers was not as high in the mere-distraction condition as in the unconscious-thought condition. This provides further evidence that the increased accessibility in the unconscious-thought condition was not due to the release of incorrect associations, as suggested by the forgetting-fixation hypothesis, but instead was possibly a consequence of a "power boost" from goal-directed unconscious thought.

Our findings regarding accessibility also extend previous research examining the role of explicit verbal reflection and neural activity in solving insight problems (Beeman & Bowden, 2000; Bowden & Beeman, 1998; Schooler, Ohlsson, & Brooks, 1993). Schooler et al. (1993) found that explicit verbal reflection interfered with access to insight-problem solutions. They suggested that explicit verbal reflection disrupted nonreportable, unconscious processes that typically lead to a solution. Likewise, using similar RAT problems, a number of studies have linked the increased accessibility of solutions to unsolved problems to activity in the right hemisphere, which is generally thought to govern holistic reasoning and coarse semantic associations (Beeman & Bowden, 2000; Bowden & Beeman, 1998). These previous studies provided only suggestive evidence for the involvement of unconscious processes in creativity because unconscious processes were not explicitly controlled or measured. Our experiment, however, provides direct evidence for the causal relationship between unconscious thought and increased solution-related activation. By differentiating implicit accessibility and conscious reporting of correct answers, we were able to reconcile the gap between the anecdotal evidence for the role of unconscious processes in creative discoveries and the lack of empirical support for the effect of incubation. Unconscious activation may provide inspirational sparks underlying the "Aha!" moment that eventually leads to important discoveries.

EXPERIMENT 2

A key distinction between conscious and unconscious thought is that the former excels at linear search and analytic processing and the latter is better at associative processing (Dijksterhuis & Nordgren, 2006). As a result, conscious and unconscious thought have differential effects on decision making depending on the level of difficulty. In a recent experiment (Dijksterhuis, Bos, Nordgren, & van Baaren, 2006), participants had to choose among four hypothetical Japanese cars (one had more positive features than the others). Each car was described by 4 features in the easy condition and by 12 features in the difficult condition. In the easy condition, conscious thought outperformed unconscious thought, but under more demanding circumstances, unconscious thought outperformed conscious thought. Similarly, Dijksterhuis and Meurs (2006) asked people in conscious- and unconscious-thought conditions to list names of places (cities, towns, etc.) beginning with certain letters. Unconscious thinkers listed more small towns and villages than conscious thinkers, but the advantage of unconscious thought was absent (in one study) or even reversed (in another study) for names of big cities. This suggests that the advantages of unconscious thought in solving RAT problems should be most prominent when the problems involve remote or weak associations. When associations are strong and obvious, the benefits of unconscious thought should disappear (or even be reversed), and the linear and analytic search process of conscious thought should be just as effective as or even superior to the associative process of unconscious thought in discovering the common link in the problems (Bowden & Jung-Beeman, 2003).

Method

Participants and Design

The participants were 36 undergraduate students (9 male, 27 female; median age = 20 years) who volunteered for the study. The experiment used a 2 (processing style: conscious thought vs. unconscious thought) × 2 (target words: RAT answers vs. control words) mixed factorial design, with the former being the between-participants factor.

Materials and Procedure

The procedure of Experiment 2 was exactly the same as that of Experiment 1 except that we did not differentiate unconscious thought from mere distraction, so participants were randomly assigned to only two conditions: unconscious or conscious thought. The main difference from Experiment 1 was in the materials; we used a different set of RAT problems. We selected 12 moderately difficult RAT triads from Bowden and Jung-Beeman (2003; see Table 2); these triads produced correct answer rates between 41% to 59% when tested on 39 participants (Bowden & Jung-Beeman, 2003).

Results and Discussion

Correct RAT Answers

As expected, participants had moderate difficulty resolving the RAT items; across the conditions, participants correctly solved 47% of the triads, on average. Unlike in Experiment 1, participants in the conscious-thought condition correctly solved significantly more RAT items (M = 6.83, SD = 3.24) than did participants in the unconscious-thought condition (M = 4.44, SD = 3.20), $F(1, 34) = 4.95$, $p = .03$, $p_{rep} = .91$.

Response Latencies

After excluding response latencies more than 1,000 ms and less than 300 ms, we submitted the data to a 2 (processing style: conscious thought vs. unconscious thought) × 2 (target words: RAT answers vs. control words) mixed analysis of variance. The significant interaction between processing style and target words found in Experiment 1 was no longer present, $F(1, 34) = 1.35$, $p = .25$, $p_{rep} = .68$. Participants in the conscious-thought condition (M = 596.34 ms, SD = 70.29) and participants in the unconscious-thought condition (M = 582.98 ms, SD = 89.85) had similar response latencies; in addition, response latencies to control words did not differ between the conscious-thought condition (M = 646.83 ms, SD = 76.09) and the unconscious-thought condition (M = 662.39, SD = 89.74). As in Experiment 1, across the two conditions, the correlation between response latencies for the answers and the number of correct answers was not significantly different from zero ($r = -.23$, $p = .18$, $p_{rep} = .74$).

TABLE 2

Triads Used in the Remote-Association Test in Experiment 2

Triad			Answer
light	birthday	stick	candle
wheel	hand	shopping	cart
cross	rain	tie	bow
boot	summer	ground	camp
catcher	food	hot	dog
wagon	break	radio	station
health	taker	less	care
down	question	check	mark
carpet	alert	ink	red
blank	list	mate	check
test	runner	map	road
man	glue	star	super

Note. All triads in this experiment were moderately difficult to solve.

Discussion

Experiment 2 supported our predictions. We did not find any difference in accessibility of RAT answers between the conscious-thought and unconscious-thought conditions when RAT items were easier than in Experiment 1. Thus, Experiment 2 conceptually replicated the study by Dijksterhuis and Meurs (2006). In addition, we found that conscious thought produced more correct answers to these moderately difficult RAT problems than unconscious thought did. Together, Experiments 1 and 2 show that unconscious thought can facilitate discovering remote, but not local, associations. However, these associations discovered in unconscious thought do not necessarily enter into consciousness.

GENERAL DISCUSSION

When a printer is not printing the calculations from a computer program properly, it is not always because the program is not working. Instead, the printer may be broken, or the connection between the computer and the printer may be severed. Oversimplified as it is, we suggest that this metaphor may account for the lack of empirical support for the incubation effect. We conceptualize incubation as involving two relatively independent steps. In the first step, unconscious thought "boosts" the associative search for creative solutions. In the second step, solutions are transferred to consciousness. A failure of either step will lead to the absence of empirical support for incubation. Thus, previous research may have underestimated both the importance and the complexity of incubation in creative processes and therefore may have looked for the incubation effect in the wrong place.

Experiment 1 is consistent with this reasoning. It found that, compared with an equal duration of conscious contemplation or mere distraction, unconscious thought enabled participants to better narrow in on the solutions to creative problems, an effect that was reflected in increased accessibility of correct RAT answers in a standard lexical decision task.

However, this increased activation did not result in the conscious reporting of more correct RAT answers. In this experiment, we purposefully selected RAT problems that are extremely difficult so that the increased accessibility could not be attributed to anything but differences between thought processes. Experiment 2 used RAT problems that were only moderately difficult and found that participants in the conscious- and unconscious-thought conditions had similar accessibility to RAT answers, but those who had engaged in conscious thought reported more correct answers than those who had not. These findings are fully in line with unconscious-thought theory, which proposes that conscious thought is better at making linear, analytic decisions, but unconscious thought is especially effective at solving complex problems (Dijksterhuis & Meurs, 2006; Dijksterhuis & Nordgren, 2006).

Although we have drawn a distinction between conscious and unconscious output, we are not proposing that there is any inherent, fundamental difference between conscious and unconscious representations. Rather, cognitive representations are best considered as activations at different "levels of consciousness." Some researchers, for example, view accessibility as a readiness to think of something consciously (Bruner, 1957; Higgins, 1996). In these conceptualizations, however, there is a linear relationship between activation and consciousness: Unconscious activation increases until it breaks a certain threshold and becomes consciously present, and the greater the level of unconscious activation, the more likely that this activation will enter consciousness.

Our findings call into question this direct correspondence between activation and consciousness (see also Wegner & Smart, 1997). In these two experiments, we found that greater unconscious activation did not increase conscious reporting of correct answers (Experiment 1) and that similar levels of activation corresponded to different levels of conscious performance (Experiment 2). Furthermore, in both experiments, there was no correlation between accessibility and reporting of correct answers. Although it is possible that the lack of correlation in Experiment 1 was due to restriction of range in the number of correct answers, this concern was alleviated in Experiment 2, in which participants on average consciously solved half of the RAT problems. Thus, the level of unconscious activation does not appear to be the only factor that determines the likelihood that an unconscious representation will enter into consciousness.

What are the implications of the current research for creative discoveries? If inattention is indeed better than concentration in resolving complex problems, should artists or scientists simply engage in daydreaming to produce groundbreaking discoveries or trail-blazing artistic creations? We suspect that although unconscious thought processes are more powerful than conscious thought processes in connecting remotely associated elements, for associative search to function there will have to be a plethora of raw materials available to be connected. In this sense, unconscious thought cannot "create" knowledge; conscious learning and processing are needed to establish a knowledge base. More important, Experiment 1 found that only when inattention was directed by a meaningful goal did it increase solution-related activation (i.e., accessibility did not increase in the mere-distraction condition). Without conscious learning and thought, mathematicians and scientists would not be able to know what problems to tackle, and artists would get lost in the vast array of options available; without goals, inattention is simply walking in darkness.

These points raise the question of what combination of conscious and unconscious thought is most fruitful for allowing insights and discoveries to be articulated and implemented. Should a period of conscious thought be followed by a period of unconscious thought and then another round of conscious thought? The finding that conscious thought led to similar levels of accessibility but more correct answers than unconscious thought in Experiment 2 may suggest that unconscious thought should be applied to find solutions, whereas a subsequent period of conscious thought increases the probability that these solutions enter into consciousness. We hope that after a period of unconscious reflection, future researchers will tackle the arduous task of discovering when creative ideas given increased accessibility by unconscious thought will spring forth into consciousness.

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