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Creative and analytic thinkers differ in their use of attentional resources☆

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Abstract

Creativity involves linking ideas previously seen as unrelated. The creative thinker must attend to elements that are relevant to the current problem while recording seemingly irrelevant information that may lead to insight. Thus, creative thinkers should use peripherally presented cues effectively. Good analytic thinking should be characterized by sustained directed attention because solutions to analytic problems require focus on the problem elements. We predicted that creative thinkers would take advantage of incidentally presented cues, whereas analytic thinkers would not. We used a remote associates test (RAT) to measure creativity and deductive reasoning problems to measure analytic ability. To measure sensitivity to peripheral cues, we adapted a task from Mendelsohn and Griswold (1966). Multiple regression analyses demonstrated that RAT scores predicted ability to use peripheral cues, whereas scores on the deductive task did not.

Keywords: Creativity; Insight; Focused attention; Diffusion attention; Creative problem solving

"Among the combinations we choose, the most fruitful are often those which are formed of elements borrowed from widely separated domains" (Poincaré as quoted by Miller, 1996, pp. 354–355). Poincaré's introspective notion about the creative process reflects the modern view that innovative solutions often result from the selective combination of elements previously seen as unrelated (Ansburg, 2000; Finke, Ward, & Smith, 1992; Lubart, 1994; Nickerson, 1999; Sternberg, 1988). These remote associations are a required component of the divergent thinking that characterizes creative thought (Finke et al., 1992). The present work explored the role attention

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plays in the production of such surprising, yet sensible associations. Attention in the present work is defined as "...the capacity to select the creative combination from among the many mediating associational links which may occur to an individual" (Mendelsohn, 1976, p. 342). In particular, we were interested in determining whether a certain pattern of attentional resource allocation was uniquely related to the ability to produce remote associates.

The opportunistic-assimilation hypothesis asserts that creative connections occur when the thinker unwittingly encounters a trigger in the environment (Seifert, Meyer, Davidson, Patalano, & Yaniv, 1995). That is, when a thinker declines to allow the elements of the problem at hand to be the sole object of his/her attention, he/she sets the stage for the production of innovative connections. Consider, for example, the following quote from an advertising creative describing how he/she intentionally diffuses attention to alleviate a block:

> The creative director and I will begin just talking, often laughing, about whatever the problem puts us in mind of...listening to every word the other person is saying and keeping your internal monitor turned up full blast...so you are sure to detect the wonderful beginning of an idea in a throwaway phrase (quoted in Moriarty and Vandenbergh, 1984, pp. 168–169).

According to Finke et al. (1992) and Martindale (1995) focused attention increases the probability that strong associates will be accessed while decreasing the likelihood that remote associates will be accessed. Diffuse attention, however, increases the likelihood that remote associates will be accessed (Finke et al., 1992; Martindale, 1995). Thus, individuals who cast broad attentional nets are more likely to capture unexpected cues and to generate remote associations than are those whose cognitive resources are more narrowly focused. There is some empirical support for this notion.

One paradigm used to investigate the relationship between attention and creativity places participants in a situation that requires divided attention (e.g., dichotic listening tasks). The pattern of results found on these tasks is that those who are creative and thus routinely allocate their attention in a diffuse manner have more difficulty completing the target task than do those who are less creative and thus maintain a more narrow focus. For example, Dykes and McGhie (1976) found that under certain conditions, highly creative individuals showed more shadowing errors on a dichotic listening task than did less creative individuals. Dykes and McGhie interpreted this finding as indicating that "the habitual attentional strategies employed by creative (individuals)...appear to sample a wider range of environmental input than do other individuals" (Dykes & McGhie, 1976, p. 55). Rawlings (1985) reported a similar finding: when participants were told to shadow one ear, but also try to remember information from the non-shadowed ear, creative individuals showed more intrusion errors on the shadowing task than did less creative individuals; however, compared to the less creative participants, creative individuals showed a better memory for the secondary information. Thus, creative individuals were better able to complete a task that required diffuse attention (i.e., the memory task) than were the less creative individuals; but, the pattern was reversed for the focused attention task (i.e., shadowing).

Other researchers have assessed the relationship between attentional breadth and creativity in the context of problem solving. Kasof (1997) demonstrated that those who rated themselves as being typically unable to screen out environmental distractions produced more creative poems than those who reported that they easily screen out distracters. Further, Kasof found that the creative output of those who reported this broader range of attention was more severely impaired by environmental noise than was the work of those who reported a more narrow range of attention. Mendelsohn and Griswold (1966) found that, when solving anagrams, creative individuals were more likely to take advantage of incidentally presented hints than were those who scored lower on a measure of creativity. Finally, Mendelsohn (1976) reviewed several empirical works that showed a positive relationship between measures of attentional capacity and both non-verbal and verbal indicators of creativity.

Although the evidence provided in the aforementioned studies are consistent with the notion that "extensive attention determines the originality and productivity of thinking" (Kolańczyk, 1989, p. 66), it must be made clear that creative thinking has to include an eventual narrowing of attention. Creative thought must involve mechanisms that encourage the unconstrained exploration of diverse ideas and mechanisms that allow for focused tests of solution appropriateness. A wholly diffuse attentional strategy if not reigned in could prove quite maladaptive (see Dykes & McGhie, 1976 for a description of attentional strategies used by Schizophrenics). Thus, although creative individuals seem to have a propensity toward allocating attention broadly, when the situation demands, they are able to harness their cognitive resources and focus attention so that they can complete the task at hand (Dykes & McGhie, 1976). In fact, Martindale (1995), in his description of a connectionist model of creativity, asserted that the ability to change cognitive states between defocused and focused attention is a crucial characteristic of creative thinking. Further, Nęcka (1999) reported that the more creative his participants were the more slowly they were able to identify target letters among distracters; however, there was no difference between creative and non-creative individuals in accuracy on this simple selective attention task. Nęcka suggested that the observed slow down was due to the creative individuals' affinity for novel stimuli that can sometimes sidetrack their thinking—but only temporarily and without detriment to accuracy. Stavridou and Furnham (1996) argued that creative people can strategically inhibit peripheral information when necessary. Thus, it appears that creative individuals have some flexibility regarding the allocation of their attentional resources. However, creative individuals habitually allocate attention in a diffuse manner (Dykes & McGhie, 1976).

An important issue not addressed by previous work is whether the tendency to broaden attention span is uniquely related to creative problem solving. In other words, is this pattern of resource allocation indicative of good creative problem solving or of good problem solving in general? There is evidence that there are general problem solving skills that underlie both creative and analytical problem solving (Ansburg, 2000). The question addressed here is whether the ability to diffuse attention is a trait possessed by creative individuals or whether the tendency to gather as much information as possible characterizes good analytical thinkers as well. Analytical thinking (e.g., deductive reasoning) is often contrasted with creative thinking, as the former involves discrimination and the latter synthesis (Feist, 1991). Creative thinking produces innovative solutions, whereas analytic thinking evaluates and tests existing ideas (Nickerson, 1999). Most individuals predominantly employ either creative or analytic thought (Nickerson, 1999). Martindale (1995) argued that analytic and creative thinking cannot occur simultaneously:

> A creative insight is not possible with this sort of thinking (deductive reasoning) because the conclusion is implicit in the premises. We could think of (deductive reasoning)...as crystalline. It is nicely structured, but the probability of two remote atoms bumping into each other is zero (p. 258).

It seems reasonable to assume that any mode of problem solving would be facilitated by an increase in availability of information. If this is the case, then all good problem solvers should exhibit a tendency to maintain a broad attention span. On the other hand, it is possible that the acquisition of a large amount of information results in a trade-off of crucial processing capacity. That is, for some types of problems (e.g., deductive reasoning problems) gathering incidental information may not allow efficient and effective processing of more central information. Because analytic thinking involves an evaluation/dissection of the problem elements, sustained focus on the problem elements is required for solution—attention directed to peripheral items simply wastes cognitive resources (Dykes & McGhie, 1976). This line of reasoning suggests that analytic thinkers should not exhibit an inclination to diffuse attention. Therefore, the propensity to allocate attentional resources to aspects of the problem solving situation which are not obviously central should be uniquely characteristic of creative thought and not exhibited by analytic thinkers. To test this notion we replicated and extended the work of Mendelsohn and Griswold (1966) on sensitivity to cues. Mendelsohn and Griswold's procedure allowed us to assess whether creative and analytic thinkers differ in their ability to record and access cues to solutions that are presented as a distraction (e.g., peripherally presented). If it is true that creative thinkers direct cognitive resources in diffuse manners, then creative thinkers should be able to take advantage of hints presented peripherally. If analytic problem solving is hindered by diffuse attention, then analytic thinkers should be relatively insensitive to the cues presented peripherally.

1. Method

1.1. Participants

Data were collected from 204 college students, who participated to fulfill a requirement for the Introduction to Psychology class. However, the data from 28 of those students were unusable: 19 were eliminated due to equipment failure, four of the participants were non-native English speakers and five participants did not follow instructions. Therefore, 95 females, 80 males, and one participant who did not indicate his/her sex made up the final sample. The participants' average age was 22.14 (S.D. = 5.91).

1.2. Materials

We adapted the materials and procedures described by Mendelsohn and Griswold (1966). A list of 30 five-letter anagrams was adapted from Mendelsohn and Griswold. Ten of the solutions to these anagrams were randomly assigned to be included in the peripheral cue list, and a different 10 of the solutions to these anagrams were randomly assigned to be included in the focal cue list. A 10-min CD was created on which a list of 25 words was repeated by a female voice other than that of the experimenter at normal volume. Ten of the words on the CD were anagram solutions, and the other 15 were selected to match the anagram list for Thorndike–Lorge (1944) frequency. Another list of 25 words was typed in a single column on an unlined 8.5 by 11-inch paper. Ten of these words were anagram solutions and the other 15 were selected to match the anagram list for Thorndike–Lorge frequency. Because some of the vocabulary from Mednick's (1962) original

Remote Associates Test has become unfamiliar, an updated remote associates test (RAT) from Smith and Blankenship (1991) was used to assess creative problem solving ability. RAT problems require solvers to find a connection between three seemingly unrelated words: find a fourth word that is related to the following three "Lick" "Sprinkle" and "Mines" (Answer: Salt). Thus, performance on remote associate problems is intended to reflect an individual's ability to develop new combination of items that are useful and/or appropriate (Mednick, 1962). Mednick (1962) reported that scores on the RAT were positively related to graduate advisors' ratings of their students' research creativity and architects' scores on an originality test. However, there are data (Backman & Tuckman, 1972; Goodman, Furcon, & Rose, 1969) which question whether the remote associate test is an adequate way to operationalize creativity. Nonetheless, Ansburg (2000) found that the fluency of thought required for strong performance on remote associate problems was also required for success on verbal insight problems. Thus, it seems reasonable to assume that successful performance on RAT items at the least shares some of the same cognitive processes involved in the production of creative insight. In the present study, the internal consistency for the remote associate problems used was $\alpha = 0.74$. A packet of six deductive reasoning problems, one per page, was used to assess analytical problem solving ability. The deductive reasoning problems were developed by the first author. Here is a sample deductive reasoning problem: Adam is older than Bob and Carl. Carl is older than Dick. Eli is younger than Bob but older than Dick. Eli is younger than Carl. Adam is younger than Mark. Who is the second oldest man in this group? (Answer: Adam). On the present sample, the internal consistency of the deductive reasoning measure, as assessed by Cronbach's alpha, was 0.62.

1.3. Procedure

The procedure was a partial replication of Mendelsohn and Griswold's (1966) study. Participants were given 10 min to memorize a list of 25 words while another list of 25 words repeatedly played in the background. Participants were told to concentrate on the list in front of them and to ignore the words being read aloud. Unbeknownst to the participants, some of the words on these lists were the solutions to anagrams that they would be asked to solve later in the study. Thus, the background words were considered peripheral cues, whereas the to-be-remembered items were focal cues. Participants were given 10s to solve each of 30 anagrams. Ten of the anagrams' solutions were the focal cues, 10 solutions were the peripheral cues and 10 solutions had not been previously presented. After solving the anagrams, participants spent 5 min attempting to recall the focal list and 5 min attempting to recall the peripheral list. Next, the researcher read the instructions for the RAT and gave participants 10 min to solve 20 problems. Finally, participants were asked to solve six deductive reasoning problems. There was a 2-min time limit per problem.

2. Results

Table 1 displays the descriptive statistics for the critical variables. The average performance on both the RAT and the deductive reasoning problems was rather low. Thus, all future references to creative and analytic thinkers are to be understood as reflecting relative rather than absolute levels of each ability. The recall performance on the focal and peripheral cues served as a

Table 1
Descriptive statistics for critical variables[a]

Variable	*M*	S.D.	Range
RAT score	34.2	15.3	0–70
Deductive reasoning score	42.5	16.3	0–83
Focal anagrams solved	56.5	19.4	10–100
Peripheral anagrams solved	38.6	19.1	0–90
Control anagrams solved	43.9	19.7	0–100
Focal cues recalled	69.1	8.8	12–100
Peripheral cues recalled	8.8	7.1	0–36

[a] Numbers are percentages.

manipulation check. As hoped, the participants were relatively successful at memorizing the focal list and at ignoring the peripheral list.

2.1. Predictors of peripheral cue utilization

A multiple regression analysis determined whether thinking style predicted ability to benefit from peripheral cues. The predictor variables were scores on the RAT, scores on the deductive reasoning task and performance on control anagrams (to account for anagram solving ability). The dependent variable was performance on the peripheral anagrams. Tables 2 and 3 show the intercorrelations between the variables of interest and the regression analysis summary, respectively. These data show that even when anagram-solving ability (operationalized by performance on control anagrams) was partialled out creative thinking significantly predicted ability to diffuse attention and take advantage of peripherally presented cues. These results replicated the work of Mendelsohn and Griswold (1966). Analytic thinking, on the other hand, did not significantly predict performance on the peripheral anagrams.

Table 2
Intercorrelations between problem solving and memory performance

Variable	1.	2.	3.	4.	5.	6.	7.
1. Peripheral anagram performance	–	0.36***	0.41***	0.41***	0.13	0.26***	0.16**
2. Focal anagram performance		–	0.40***	0.32***	0.28***	0.04	0.37***
3. Control anagram performance			–	0.29***	0.22***	0.019	0.22**
4. RAT score				–	0.30***	−0.02	0.22**
5. Deductive reasoning score					–	−0.01	0.25***
6. Recall peripheral cues						–	−0.06
7. Recall focal cues							–

** $P<0.01$.
*** $P<0.001$.

Table 3
Regression analysis summary for thinking abilities predicting ability to diffuse attention

Variable	β	Standard error of beta	Standardized multiple regression coefficient	Partial correlation[a]	Part correlation[b]
RAT score	0.41	0.09	0.33***	0.33***	0.30***
Deductive reasoning score	0.05	0.08	−0.04	−0.04	−0.04
Control anagrams solved	0.31	0.07	0.32***	0.33***	0.30***

Adjusted $R^2 = 0.243$ ($N = 176$, $P < 0.001$).

[a] Partial correlations are between each predictor variable and performance on peripheral anagrams controlling for the other predictor variables.

[b] Part correlations are between each predictor variable and performance on peripheral anagrams controlling for the other predictor variables.

*** $P < 0.001$.

2.2. Predictors of focal cue utilization

Both creative and analytic thinking significantly predicted use of focal cues (see Tables 2 and 4). Table 4 shows the data regarding a multiple regression analysis that used RAT scores, deductive reasoning scores and performance on control anagrams to predict solution rates to focal anagrams. When anagram-solving ability was controlled (measured via performance on control anagrams), these relationships were quite weak. We were surprised by this finding because we assumed that the ability to transfer focally-presented, solution-relevant information would be indicative of problem solving skill in general. A look at the descriptive statistics (see Table 1) regarding RAT performance, deductive reasoning performance and focal anagram performance shows that it is unlikely that this null finding can be attributed to restricted ranges on these tasks. Further, although Mendelsohn and Griswold (1966) found that moderate RAT scorers were less

Table 4
Regression analysis summary for thinking abilities predicting ability to focus attention

Variable	β	Standard error of beta	Standardized multiple regression coefficient	Partial correlation[a]	Part correlation[b]
RAT score	0.23	0.09	0.16*	0.19**	0.17*
Deductive reasoning score	0.19	0.08	0.18*	0.17*	0.15
Control anagrams solved	0.30	0.07	0.31***	0.31***	0.30***

Adjusted $R^2 = 0.213$ ($N = 176$, $P < 0.001$).

[a] Partial correlations are between each predictor variable and performance on focal anagrams controlling for the other predictor variables.

[b] Part correlations are between each predictor variable and performance on focal anagrams controlling for the other predictor variables.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$.

likely to use focal cues than were either high RAT or low RAT scorers, no such curvilinear relation with focal cue use was detected in the present study for either RAT scores or for deductive reasoning scores (see Table 5). To the contrary, our results suggested the expected linear relationship. One possible explanation is that once a thinker solved an anagram whose solution was on the focal list, that solver made the connection and began using a strategy of trying to remember the items on the focal list and solution-testing them. Those with greater anagram solving ability, regardless of their creative and analytic abilities, would solve more anagrams and thus be more likely to solve anagrams whose solutions were on the focal list than would those who have less anagram solving ability. Thus, the better the participant was at solving anagrams, the more likely he/she was to encounter anagrams whose solutions would point to the strategy of using the memorized list as a pool of potential answers. Consistent with this explanation is the finding of a positive correlation between recall of focal items and solutions to focal anagrams (see Table 2).

2.3. Relationship between recall of items and problem solving performance

The data describing recall of focal and peripheral items must be interpreted rather carefully because recall was always tested after the anagram solving phase; thus, performance on the recall tests is likely to have been influenced by performance on the anagrams. See Table 2 for the correlations between explicit recall of items and problem solving performance. Explicit recall of *focal* items was positively related to performance on all problem solving tasks. It is possible that this intentional memory task provided an indicator of working memory capacity for verbal material and thus was an indicator of general verbal ability. Explicit recall of *peripheral* cues was related only to performance on peripheral anagrams. One way in which this finding can be interpreted is that thinkers who remembered the peripheral cues were more likely to be able to use those cues while solving the anagrams. However, it is also possible that those who solved the peripheral anagrams activated primed representations of the peripheral cues and thus were able to produce the cues on the subsequent recall test.

3. Discussion

The results from the present work showed that those who tend to make unusual connections are more likely to allocate their attention in a diffuse manner than are those who are more analytical. The data presented here suggest that allocating attention broadly is not a strategy routinely employed by all good problem solvers. Instead, this cognitive trait may be one that

Table 5
Mean solution rates for focal anagrams by level of remote associates test (RAT) and deductive reasoning performance

Level of performance	Deductive reasoning	RAT
Low	50.4 (20.7)	49.8 (18.9)
Middle	52.7 (19.8)	54.4 (18.9)
High	60.9 (17.7)	65.5 (17.8)

All numbers are percentages and number in parentheses is standard deviation.

distinguishes creative problem solving from other kinds of problem solving. There is much debate in the cognitive literature regarding whether creative solutions are achieved through qualitatively different processes than those applied in the development of more routine solutions (Metcalfe & Wiebe, 1987; Schooler & Melcher, 1995; Weisberg, 1986). The finding that creative thinkers use a different cognitive resource allocation strategy than do analytic thinkers is consistent with the view that creative problem solving is distinct from other kinds of problem solving. Although the findings reported in the present piece help to advance this debate, clearly much more work needs to be done to determine what other differences underlie creative and analytic problem solving.

For example, perhaps creatives and non-creatives differ in terms of their implicit memory processes. In the present work both RAT scores and recall of peripheral cues were positively related to performance on the peripheral anagrams, yet there was no evidence for a relationship between RAT scores and recall of peripheral cues. Thus, explicit memory of peripheral cues cannot account for the creative thinkers' advantage in solving the peripheral anagrams. Instead of relying solely on explicit memory processes, creative individuals may be able to take better advantage of their implicit memory processes than are the less creative individuals. Shaw and Conway (1990) found that during a word-detection task creative individuals were more sensitive to nonconscious information than were less creative individuals; that is, highly creative thinkers were more likely to produce unconsciously primed solutions than were the less creative thinkers. Schooler, Ohlsson, and Brooks (1993) found that when participants were forced to become aware of their problem–solving procedures through verbalization insightful problem solving was inhibited. Shaw (1992) suggested that creative individuals more than non-creatives gather information using attentional processes that occur beneath awareness. According to Shaw (1992), this unmonitored stream of information activates prior knowledge and can account for the suddenness with which creative solutions "pop" into awareness.

Along with helping to enumerate cognitive differences among creative and analytic thinkers, the findings presented here may explain why incubation effects are so empirically elusive. An incubation effect occurs when taking a break from work on a difficult problem facilitates its eventual solution. Although anecdotal claims about the benefit of diverting attention from a seemingly intractable problem abound, empirical documentation of incubation effects has been mixed (Browne & Cruse, 1988; Dominowski & Jenrick, 1972; Dreistadt, 1969; Olton, 1979; Olton & Johnson, 1976; Patrick, 1986; Smith & Blankenship, 1989, 1991). It is possible that an inability to find consistent effects of incubation simply reflects the fact that incubation periods do not benefit all individuals. Thus, studies which do not attempt to measure or control individual differences in the ability to take advantage of an incubation period lack sufficient power to detect incubation effects. Consider the following explanation of incubation: failed solution attempts partially activate (or sensitize) target items and an incubation period allows the activation of the sensitized information to build until that information appears in consciousness (Yaniv & Meyer, 1987). One way the sensitized information can increase in activation is when the solver encounters stimuli in the environment that act as retrieval cues for the sensitized information (Dorfman, Shames, & Kihlstrom, 1996; Seifert et al., 1995). If an individual routinely allocates attention so as to grasp as much as possible from the environment, that individual increases the chances that he/she will hit on a relevant piece of information (Olton, 1979). Therefore, we predict that those who have a propensity to diffuse their attention are more likely to benefit from an incubation period than are those whose attentional resources are narrowly focused.

Another issue that might be explored by future research is whether individuals can be trained to allocate attention in a diffuse manner and hence improve creative thinking, if indeed breadth of attention is a causative agent of creative thought as suggested by Finke et al. (1992) "...(to promote creative solutions, one might) deliberately defocus one's attention" (p. 185). There is some evidence to suggest that this path may be fruitful. Dallob and Dominowski (1993) found that when participants' attention was experimentally drawn to certain aspects of insight problems solution rates increased significantly. Ansburg and Dominowski (2000) showed that strategic instructions intended to help thinkers broaden their search for solutions coupled with specialized practice promoted insightful problem solving. Of course, unless future work demonstrates that the cognitive habit of attentional breadth can be trained, it will remain unclear as to whether this trait is a cause or a byproduct of creative thinking.

The present work extends what is known about individual differences in cognitive processing. In particular, the findings reported here help to draw distinctions between types of good thinking. That is, the focus of the present piece was to begin to delineate what makes creative problem solving special relative to analytical problem solving rather than relative to poor problem solving. Although the measure of creativity used in the present work is controversial (and future work should replicate these findings using other measures of creative problem solving), these results are the first to provide direct evidence that the tendency to allocate attention in a broad way is characteristic of creative thinking and is not a propensity shared by all good problem solvers. However, it is important to note that these findings do not imply that those with a broad attentional capacity are creative. Instead, it is better to think of this tendency to allocate attention in a diffuse way as a cognitive propensity that serves to promote creative solutions (Mendelsohn, 1976).

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