

Dissociating Divergent Thinking and Creative Achievement by Examining Attentional Flexibility and Hypomania

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Creativity is predominantly measured in scientific research with divergent thinking tasks that assess the potential for creative ideation. The current study aimed to further foster a distinction between divergent thinking and a second measure of creativity, creative achievement (the production of tangible or visible pieces), by examining whether these 2 measures are differentially related to attentional flexibility and hypomania. Evidence was found linking divergent thinking to better attentional flexibility and creative achievement to poorer attentional flexibility in a novel variant of the Stroop task. Additionally, creative achievement, especially nonscience-related (e.g., artistic) achievement, was positively associated with risk for hypomania whereas divergent thinking was not related to hypomania. The findings support a distinction between measures of creativity (divergent thinking ability vs. creative achievement), which may have clinical implications (e.g., for bipolar disorder) and theoretical implications for the study of attentional flexibility and rigidity.

Keywords: creativity, bipolar mood, cognitive control, divergent thinking, creative achievement

Many individuals describe themselves as creative, whether they have strong talent in the visual arts, compose music, experiment with culinary ingredients, or publish scientific papers. Although individuals easily label themselves or others as creative beings, the fundamental determinants of “creativity” have been difficult to measure scientifically. Creativity is often conceptualized as flexible thinking (Baird et al., 2012; Jarosz, Colflesh & Wiley, 2012; Kim, Hasher, & Zacks, 2007; May, 1999; Vartanian, 2009), as captured in Groborz and Nečka’s (2003) definition of creative people as “flexible in their thinking, able to generate many remote associations, and tolerant to ambiguous situations” (p. 185). But definitions of creativity vary, with some referring to the production of creative work. For instance, Sternberg and Lubart (1999) define creativity as “the ability to *produce* work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful concerning task constraints)” (p. 3). Not surprisingly, then, there are multiple approaches to measuring creativity, and the current study was concerned with two distinct measures—divergent thinking and creative achievement.

Divergent thinking refers to high potential for creative ideation and activation of associational networks to generate multiple unique solutions in a limited time period (Carson, Peterson, & Higgins, 2005), whereas creative achievement is the actual novel

and useful production of works of art, such as music or a painting, over the course of one’s lifetime (Carson et al., 2005). Divergent thinking has often been assessed with the Abbreviated Torrance Test for Adults (ATTA) in which participants generate creative solutions to novel verbal and figural problems to examine creative potential. Creative achievement, in contrast, has been assessed by the Creative Achievement Questionnaire (CAQ), which asks participants to report their previously completed creative achievements in a questionnaire format (Zabelina & Beeman, 2013; Zabelina, O’Leary, Pornpattananangkul, Nusslock, & Beeman, 2015; Zabelina, Robinson, Council, & Bresin, 2012; but see Kim, 2006, for an alternative approach). Because divergent thinking ability and creative achievement are defined differently and measure unique aspects of creativity, namely creative ideation on a timed laboratory task and creative production during one’s lifetime, measures of divergent thinking ability and creative achievement may not correlate.¹ Indeed, extant research has demonstrated that the ATTA and CAQ tend not to correlate (Zabelina et al., 2015; Zabelina & Robinson, 2010), suggesting that divergent thinking and creative achievement represent at least partially unique measures (but see Kim, 2006, for evidence of a relationship between divergent thinking and creative achievement, with use of an alter-

¹ As an anonymous reviewer pointed out, one might alternatively reason that divergent thinking ability and creative achievement should be correlated because individuals with greater creative potential should also be those that are most likely to create actual products. We suppose this may be true if divergent thinking ability was measured by assessing creative potential in the same domains indexed by the creative achievement questionnaire. However, that was not the case in the current study or in studies that motivated the current approach and that reported that divergent thinking ability and creative achievement are unrelated (e.g., Zabelina & Beeman, 2013; Zabelina et al., 2015).

This article was published Online First August 8, 2016.

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native measure of creative achievement). Further supporting this conclusion, correlations between creativity and various psychological outcomes vary across the two measures of creativity (see Zabelina & Beeman, 2013; Zabelina et al., 2012, 2015; Zabelina & Robinson, 2010). The aim of the present study was to further examine whether divergent thinking and creative achievement represent distinct measures of creativity by examining their relationships with novel measures of attentional flexibility and hypomania.

Creativity and Attentional Flexibility

One psychological outcome that has been examined in prior studies of creativity is cognitive flexibility. A number of studies have established that creativity is associated with the ability to think flexibly and easily form relationships between different ideas (e.g., Baird et al., 2012; Jarosz et al., 2012; Kim et al., 2007; May, 1999; Vartanian, 2009). However, the definition of creativity adopted in such studies (e.g., Baird et al., 2012; Jarosz et al., 2012; Kim et al., 2007) was restricted to divergent thinking ability and thereby use of divergent thinking tasks (e.g., ATTA) to measure creativity. As noted earlier, creativity can also be defined as creative achievement, and divergent thinking measures may not tap into the cognitive profile of an individual with high levels of creative achievement. Of particular interest in the current study was examining whether the attentional biases associated with creative achievement differ from those associated with divergent thinking.

Two lines of research suggest that creative achievement may be associated with a bias to sustain an attentional focus. First, Kozbelt (2008) found that extremely creative artists are more focused, pausing significantly less and spending more time reworking pieces until satisfied, than those who are less creative (see also Fayena-Tawil, Kozbelt, & Sitaras, 2011, who highlighted how artists are driven by single goals, revising art again and again as compared to nonartists). Second, Zabelina and Beeman (2013) found that high levels of creative achievement as measured by the CAQ were associated with impaired performance on a goal-switching task in which participants had to switch their attentional set after it had been established. In other words, high levels of creative achievement were associated with a bias to sustain attention toward a given goal even after the goal was no longer relevant, which might be conceived of as attentional inflexibility. Quite interestingly, variations in divergent thinking ability as measured by the ATTA were not associated with switching costs.

In addition to the above evidence, a few other studies support the view that aspects of attentional performance may relate differentially to creative achievement and divergent thinking. Zabelina et al. (2012) found that high scores on select subscales (Originality and Fluency) of the ATTA but not CAQ scores were associated with fewer prepotent responses during a task in which participants were instructed to generate random number sequences. In other words, divergent thinking was related to the ability to avoid rather well learned or automatic tendencies to produce favored sequences such as "1, 2, 3." Most recently, Zabelina et al. (2015) found that scores on the ATTA and CAQ were differentially associated with sensory gating. Individuals who scored high on the ATTA were characterized as selective sensory gatekeepers in that they showed a tendency to filter stimuli that were not relevant to the ongoing task; by contrast, those who scored high on the CAQ were

described as leaky sensory processors and exhibited a reduced ability to screen out irrelevant stimuli. On these grounds, Zabelina et al. (2015) posited that divergent thinking tasks, which are often time sensitive, may benefit from selective sensory processing whereas real-world creative achievement may benefit from a sensitivity to stimuli or ideas outside the focus of attention.

The current study sought to further examine the attentional biases that characterize and potentially distinguish divergent thinking and creative achievement. Two novel tasks were examined. One was a letter-naming task in which a participant had to switch goals following establishment of an initial attentional set. Performance on this task was found to be negatively associated with ruminative tendencies (Altamirano, Miyake, & Whitmer, 2010). If creative achievement is associated with a tendency to persist in deploying attention toward a goal (i.e., ruminate on a goal), even after an instructed switch, then scores on the CAQ may be negatively associated with switching ability. If we conceptually replicate the results of Zabelina and Beeman (2013), then ATTA scores, in contrast, should not be related to switching ability.

The second task was a variant of the classic Stroop task in which participants name the ink color of words that themselves represent colors (e.g., responding "blue" when seeing the word *red* printed in blue ink). The variant we employed is termed the item-specific proportion congruent Stroop task (cf. Bugg & Hutchison, 2013; Bugg, Jacoby, & Chanani, 2011), and was used to measure a participant's tendency to be flexible in varying the scope of attention on a trial-by-trial basis. The correlations between creativity and performance on the item-specific proportion congruent Stroop task will serve as a meaningful contrast to the findings of Zabelina and Robinson (2010). They found that high levels of creativity, as measured either by the ATTA or CAQ, were positively correlated with increased flexibility on a color-word Stroop task as measured by the Gratton effect, which refers to a sequential modulation of the Stroop effect. In particular, creativity was associated with a greater ease in ignoring the irrelevant word after experiencing a trial that was incongruent (e.g., word *blue* in red ink) compared to a trial that was congruent (e.g., word *blue* in blue ink). This sequential modulation has been attributed to the heightening of attention on the previous trial with this heightening automatically carrying over to bias attention in a goal-relevant fashion on the subsequent trial (Botvinick, Braver, Barch, Carter, & Cohen, 2001).

In the item-specific proportion congruent Stroop task, as in Zabelina and Robinson's (2010) task, the goal was to name the ink color and the interest was in trial-by-trial variations in performance. However, our task was not designed to measure the Gratton effect but instead measured how flexibly participants varied the scope of their attention in response to two different types of items (stimuli) that occurred unpredictably throughout the task. One item type is referred to as the mostly congruent items. These are stimuli that tend to be congruent, meaning the word and color match 75% of the time such stimuli are shown. For instance, when the color blue is shown it is usually paired with the word *blue* and only occasionally with other words (e.g., *yellow*, *green*, or *red*). The second item type is referred to as the mostly incongruent items. These are stimuli that tend to be incongruent, meaning the word and color match only 25% of the time. For instance, when the color green is shown, it is usually paired with the words *red*, *blue*, or *yellow* and very rarely occurs with the word *green*. Mostly congruent and mostly incongruent items are randomly intermixed

in the item-specific proportion congruent Stroop task such that a participant cannot predict which type of item will appear on any given trial of the task. Nonetheless, prior research has established that each item type's history (proportion congruence) affects the magnitude of the Stroop effect (i.e., impaired performance on incongruent compared to congruent trials), providing evidence for a fast and flexible form of attentional control of the irrelevant word (i.e., item-level control; Bugg & Hutchison, 2013; Bugg et al., 2011). The Stroop effect is large for mostly congruent items, which is attributable to the fact that these stimuli tend to trigger a broad scope of attention that includes processing of the irrelevant word (because the word usually facilitates performance). Accordingly, when a mostly congruent item is presented in an incongruent format (e.g., *yellow* in blue ink), performance is severely slowed unless an individual rapidly and flexibly overrides that attentional bias. The Stroop effect is small for mostly incongruent items because these stimuli tend to trigger a narrow scope of attention such that the word is less fully processed (because attending to the word usually interferes with the ability to name the color). Such a bias has little to no effect on the occasion that a mostly incongruent item is presented in a congruent format (Bugg & Hutchison, 2013; Bugg et al., 2011).

Because mostly incongruent items provide contextual support that rather automatically directs attention away from the irrelevant word (Jacoby, Lindsay, & Hessels, 2003), producing overall small Stroop effects, individual differences in creativity may be most likely to manifest as variation in performance on the mostly congruent items (see, e.g., Kane & Engle, 2003, for evidence that the mostly congruent condition [list] was more sensitive to individual differences in working memory capacity than the contextually supportive, mostly incongruent condition). Given that divergent thinking ability is associated with a decreased tendency to produce prepotent (and inappropriate) responses (Zabelina et al., 2012) and selective sensory gating, which Zabelina et al. (2015) speculated may benefit time-sensitive processes, it was predicted that high scores on the ATTA may correspond to a greater ease in rapidly and flexibly overriding the prepotent tendency to attend to the word dimension when a mostly congruent item is presented in an incongruent format (leading to a smaller Stroop effect for mostly congruent items). Those with high creative achievements, in contrast, may be more likely to persist with the attentional bias that has been routinely used when responding to mostly congruent stimuli on most trials (cf. Zabelina & Beeman, 2013), thereby experiencing larger Stroop effects for mostly congruent items.

Creativity and Hypomania

A second psychological outcome we examined was hypomania. This outcome was of interest in the current study because clinical manifestations of hypomania, such as periods of positive affect or energy, have been hypothesized to be associated with creativity via cognitive processes, including cognitive flexibility (Murray & Johnson, 2010). Numerous individuals diagnosed with bipolar disorder show elevated signs of creativity (Johnson et al., 2012; Murray & Johnson, 2010; Santosa et al., 2007), and individuals in creative occupations such as composers, writers, and visual artists are at risk for mania (Johnson et al., 2012) or show some form of mania at higher rates than the normal population (Murray & Johnson, 2010). In light of these observations, a puzzling finding

is that individuals with bipolar disorder do not perform well on divergent thinking tasks, such as the ATTA (Johnson et al., 2012). One possibility is that individuals with bipolar disorder may score high on creative achievement measures, as opposed to divergent thinking measures. If so, a positive link may be found if creativity were measured by the CAQ rather than by divergent thinking ability. In line with this idea is Zabelina and colleagues' (2015) finding that creative achievement is linked to reduced sensory gating, a feature of select psychological disorders such as schizophrenia. Thus, they suggested that creativity might be linked to psychopathology, including hypomania; in contrast, they suggested that divergent thinking, which was associated with selective sensory gating, is not linked to hypomania.

Only one study to date has investigated this possibility. Zabelina, Condon, and Beeman (2014) found a positive relationship between CAQ scores and hypomania in a nonclinical population. They interpreted this relationship to mean that drive and energy, as captured by the hypomania scale, may be needed to accumulate creative achievements. Surprisingly, they also found that ATTA scores were positively correlated with hypomania. Given that Zabelina et al. (2014) did not expect divergent thinking to be correlated with hypomania, this relationship merits further investigation. The current study examined the relationship between both measures of creativity and hypomania. One novel feature of the current study was that we tested the hypothesis that the positive relationship between CAQ scores and hypomania may be evident for nonscience-related creative achievement (e.g., achievement in writing, design, visual arts) as opposed to science-related creative achievement. This prediction aligns with the observations of Johnson et al. (2012) and Murray and Johnson (2010), as well as the suggestion of Carson et al. (2005), that those individuals that excel in more artistic creative achievements may differ from those who achieve in scientific domains, including in psychopathology.

Current Study

Much past literature described creative individuals as those who can easily form relationships between different ideas, and in accordance, creativity was often measured by divergent thinking ability (e.g., Baird et al., 2012; Jarosz et al., 2012; Kim et al., 2007; May, 1999; Vartanian, 2009). However, recently, it has been noted that an additional measure of creativity (i.e., creative achievement) exists beyond divergent thinking ability, and preliminary evidence is supportive of distinct relationships between these measures of creativity and cognitive flexibility (e.g., Zabelina & Beeman, 2013; Zabelina et al., 2015). These findings motivate further investigation of possible distinctions between divergent thinking and creative achievement in relationship to attentional flexibility. The current study also aimed to investigate the question of whether the relationship between creativity and another theoretically relevant variable, namely hypomania, may depend on how creativity is measured.

A nonclinical sample completed measures of divergent thinking and creative achievement. The Hypomanic Personality Scale was administered to assess risk for hypomania (i.e., proneness to bipolar mood states; Kwapil et al., 2000), and several cognitive tasks were administered to assess attentional flexibility. It was hypothesized that creative achievement, in particular nonscience-related creative achievement, would be positively correlated with risk for hypomania, whereas divergent thinking ability would not be cor-

related with hypomania (cf. Carson et al., 2005; Johnson et al., 2012; Murray & Johnson, 2010). Further, it was hypothesized that those who scored high on divergent thinking measures would perform better on tasks requiring attentional flexibility than those who scored low on divergent thinking measures, while individuals with high creative achievement scores would be less flexible in deploying attention (or more persistent/show a sustained focus of attention; cf. Zabelina & Beeman, 2013).

Method

Participants

Participants included 97 (53 female and 44 male) undergraduate students at a Midwestern university. All participants were between 18 and 22 years of age, had normal or corrected to normal vision and color vision, and were native English speakers. Participants were recruited via a web-based scheduling system, and each received psychology course credit for their participation.

Design and Procedure

The present study assessed individual differences across a series of questionnaires and tasks using a correlational design. After obtaining consent from the participants, a brief demographics form was administered. Then the researcher administered the following questionnaires and tasks in the order listed.

Abbreviated Torrance Test for Adults (ATTA). Divergent thinking ability was measured with the ATTA, a timed test involving one verbal and two figural tasks, each of which lasted 3 min. For the verbal component, participants were asked to generate novel solutions to a problem, such as what would happen as a result of being able to fly without an airplane (Goff & Torrance, 2002). For the figural components, subjects were asked to create pictures from incomplete figures printed in the testing booklet. The ATTA assesses four components of creative thinking ability: fluency, originality, flexibility, and elaboration. Fluency is the overall number of relevant responses, originality is the novelty of each idea, flexibility is the number of different categories that each response fell into, and elaboration is the amount of detail used to communicate ideas (e.g., shading, decoration, use of titles). Following standard procedures in the testing manual, scores for each of the four components of creativity were combined with scores for further subcategories of creativity (i.e., drawing from an unusual perspective) to determine total ATTA scores for each participant (Goff & Torrance, 2002).

Hypomanic Personality Scale (HPS). The HPS has been validated as a measure indicating risk for a diagnosis of bipolar disorder or some form of mania (Eckblad & Chapman, 1986). Participants circled either true or false in response to whether or not a series of statements described their behaviors (i.e., “I often feel excited for no apparent reason”). The HPS has been used in prior studies investigating hypomania and creativity (Johnson et al., 2012; Kwapil et al., 2000).

Letter-naming task. Attentional flexibility was assessed with a brief, computerized letter-naming task (Duncan, Emslie, Williams, Johnson, & Freer, 1996) that has been shown to negatively correlate with ruminative tendencies in a nonclinical population (Altamirano et al., 2010). Participants were asked to attend to letter

pairs and read aloud letters from the left (e.g., A K = “A”) or right (e.g., H R = “R”) side of the screen while ignoring intervening number pairs (e.g., 8 4). After 10 pairs, a brief secondary cue (“+” or “-”) instructed participants to read aloud the letter on the left or right side, respectively, for the remaining five pairings (see Altamirano et al., 2010, for further procedural details). Following two blocks of practice trials to ensure that participants understood the task, there were 16 blocks of test trials, and the task lasted about 5 min. The primary dependent variable was postswitch errors, which refers to the total number of trials on which participants made an error or omitted a response after the presentation of the secondary cue indicated a switch from one attentional set (e.g., read from left) to another (e.g., read from right). Up to eight such errors could be made during the task. A higher number of errors indicated less attentional flexibility. The researcher recorded accuracy online using a covered scoring sheet (e.g., crossed off each correct response and circled each incorrect or missing response).

Item-specific proportion congruent Stroop task. Attentional flexibility was also assessed in a Stroop task variant that gauges participants’ ability to flexibly deploy attention on an item-by-item basis (see Bugg, 2012; Bugg & Hutchison, 2013; Bugg et al., 2011). Participants were instructed to name aloud the ink color in which a word was printed as fast and accurately as possible (i.e., say “green” if the word *red* is written in green ink). The words *blue*, *red*, *yellow*, and *green* were used along with their corresponding ink colors (blue, red, yellow, green). Following practice, three blocks of 192 trials were presented, separated by brief breaks. In each block, certain colors (e.g., blue and yellow) tended to appear more frequently with a congruent word (referred to hereafter as *mostly congruent items*) and other colors (e.g., green and red) tended to appear more frequently with an incongruent word (referred to hereafter as *mostly incongruent items*). For example, the color blue appeared with the word *blue* 75% of the time and an incongruent word (*red*, *yellow*, and *green*) 25% of the time. By contrast, the color green appeared with an incongruent word (*red*, *yellow*, and *blue*) 75% of the time and the congruent word 25% of the time (see Bugg & Hutchison, 2013, Experiment 1 for specific stimulus frequencies). Presentation of the mostly congruent and mostly incongruent items within each block was randomized.

On each trial, a black screen appeared for 750 ms, followed by a white fixation cross (“+”) for 250 ms. Then another black screen appeared for 500 ms, followed by the stimulus (e.g., *green* in red ink). The stimulus disappeared when participants made a response into the microphone, recording response time. The researcher coded responses by pressing colored keys that corresponded with participants’ vocal responses. If a participant corrected him/herself (i.e., “Green. I mean blue.”), then the key corresponding to the first response was pressed. If the microphone did not detect a response, or if the microphone was tripped by an extraneous noise (e.g., cough), then the trial was excluded from subsequent analyses. There were two dependent measures for both reaction time (RT) and error rate: (a) Stroop effect (i.e., degree of slowing or increase in errors on incongruent relative to congruent trials) for mostly congruent items, and (b) Stroop effect for mostly incongruent items. The task lasted approximately 25–30 min.

Creative Achievement Questionnaire (CAQ). This brief questionnaire was used to assess 10 domains of creative achievement, such as visual arts, dance, and scientific discovery. Each domain consists of seven sentences, progressing in degree of

creativity, and participants were instructed to indicate with a check mark if that sentence applied to them. For example, in the domain of visual arts, a participant can check the sentence “I do not have training or recognized talent in this area” up to “My work has been critiqued in national publications” (Carson et al., 2005). A total CAQ score was calculated in addition to two CAQ subscores, one for nonscience-related creative achievement and one for science-related creative achievement, as there is reason to suspect a difference between these two aspects of creative achievement and hypomania, where bipolar tendencies have been associated with art-making (Johnson et al., 2012). Nonscience-related creative achievements were calculated by summing all of the individual scores in the more artistic domains (visual arts, music, dance, architectural design, creative writing, humor, and theater and film), while science-related creative achievement scores were calculated by summing all of the more science-related domains (scientific discovery, inventions, and culinary arts; Carson et al., 2005).²

Participants were debriefed and thanked for their time. Each session lasted approximately 1 hr.

Results

The researchers only considered data from participants who scored at or below a 36 (the 95th percentile) on the HPS, eliminating data from two of the 97 participants to ensure that all subjects were from a nonclinical bipolar population and did not meet criteria for a clinical diagnosis of hypomania (Eckblad & Chapman, 1986).

Bivariate Pearson's r correlations were computed to determine the relationships between the ATTA and measures of attentional flexibility and hypomania. Because creative achievement increases with age, partial correlations controlling for age were computed to determine the relationships between the CAQ and measures of attentional flexibility and hypomania.³ An alpha level of .05 was used, and the p values reflect two-tailed significance tests.

Creative Achievement and Divergent Thinking

Descriptive statistics for the ATTA and CAQ are reported in Table 1. Total ATTA scores were not significantly correlated with total CAQ scores, $r(92) = .12, p = .26$ (see also Zabelina et al., 2015; Zabelina & Robinson, 2010), nor with science- or nonscience-related CAQ scores (largest $r = .14, ps \geq .19$). In addition, total CAQ scores did not correlate with any of the four

subcategories of the ATTA (fluency, originality, elaboration, and flexibility; largest $r = .11, ps \geq .30$). These patterns support the view that creative achievement and divergent thinking ability represent distinct measures of creativity.

Creativity and Attentional Flexibility

Letter naming task. All practice trials were eliminated from analyses. On average, participants made 1.43 ($SD = 1.96$) errors when cued to switch, and the range was 0 to 8 errors. Total CAQ scores were unrelated to total errors following a cue to switch, $r(92) = -.02, p = .86$. Total ATTA scores were also unrelated to total errors following a cue to switch, $r(93) = .10, p = .33$, and examining the subcategories of ATTA did not change this pattern.

Item-specific proportion congruent Stroop task. All data collected during practice trials, and all data that were scratched during the task were eliminated from analyses. Trials on which vocal responses were ≤ 200 ms or $\geq 3,000$ ms, were also eliminated and all error trials were removed for the RT analyses (cf. Bugg & Hutchison, 2013; Bugg et al., 2011). Mean RT and error rate were derived and the Stroop effect (incongruent vs. congruent) was then calculated for the mostly congruent items and mostly incongruent items. We confirmed via a 2 (Proportion Congruence: mostly congruent vs. mostly incongruent) \times 2 (Trial Type: congruent vs. incongruent) repeated-measures analysis of variance that the item-specific proportion congruence effect was observed, $F(1, 94) = 148.07, p < .001$. Replicating past studies (Bugg & Hutchison, 2013; Bugg et al., 2011), the mostly congruent items produced a larger Stroop effect ($M = 131$ ms) than the mostly incongruent items ($M = 80$ ms). This same pattern was found for error rate.

Reaction time. There was a significant positive correlation between total CAQ score and the magnitude of the Stroop effect for mostly congruent items, $r(92) = .23, p = .03$ (see Figure 1). This relationship indicates that higher levels of creative achievement were associated with poorer attentional flexibility (i.e., larger Stroop effect). There was not a correlation between total CAQ score and the Stroop effect for mostly incongruent items, $r(92) = .16, p = .13$, although this relationship was also in a positive direction.

As for divergent thinking, the total ATTA score was negatively, though not significantly correlated, with the magnitude of the Stroop effect for mostly congruent items, $r(93) = -.12, p = .25$. When considering the subcategories of the ATTA, a significant negative correlation was found between the Elaboration subscore and the Stroop effect for mostly congruent items, $r(93) = -.22, p = .03$ (see Figure 2). For the mostly incongruent items, the total

Table 1
Descriptive Statistics for Creativity Measures

Measure	Score	Minimum	Maximum	M	SD
ATTA	Total	33	88	73	9
	Fluency subscale	11	19	15	2
	Originality subscale	12	19	16	2
	Elaboration subscale	0	19	15	3
	Flexibility subscale	0	19	15	3
CAQ	Total	1	45	15	10
	Science-related	0	23	3	4
	Nonscience-related	0	43	11	10

Note. ATTA = Abbreviated Torrance Test for Adults; CAQ = Creative Achievement Questionnaire.

² Carson et al. (2005) did not find that the architecture domain nicely loaded onto the nonscientific achievement factor, as her sample may have been too young to make significant achievements in this domain. The current study included the architecture domain in the nonscience achievement scores (see also Zabelina et al., 2013). While some participants in the present sample did in fact have architecture achievements, architecture achievements had little influence on overall nonscience achievement scores ($M_s = 11.20$ vs. 11.15 when excluded) or total CAQ scores ($M_s = 14.53$ vs. 14.47 when excluded), and accordingly, none of the correlations reported in the manuscript changes when architecture scores are excluded.

³ We thank an anonymous reviewer for advising us to covary out age when examining relationships between creative achievement and our outcome variables.

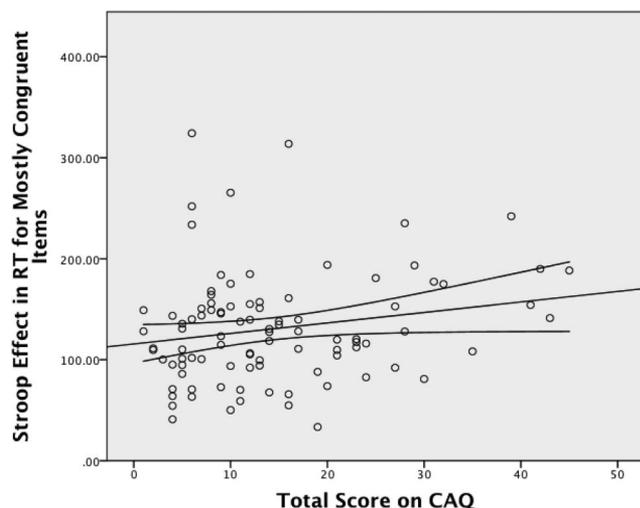


Figure 1. Bivariate correlation between Creativity Achievement Questionnaire (CAQ) score and the Stroop effect for mostly congruent items.

ATTA score was again negatively, though not significantly, correlated with the magnitude of the Stroop effect, $r(93) = -.16, p = .12$. However, there was a significant negative correlation between the Flexibility subscore and the Stroop effect for mostly incongruent items, $r(93) = -.22, p = .03$. These relationships indicate that higher divergent thinking ability was associated with better attentional flexibility (i.e., smaller Stroop effects).

Error rate. There were no significant correlations between any measure of error rate and total CAQ scores, largest $r = .09$ and $ps \geq .39$, or ATTA scores, largest $r = -.11$ and $ps \geq .28$.

Creativity and Hypomania

Total CAQ scores and HPS scores were correlated, $r(92) = .19, p = .06$, albeit not quite significantly.⁴ This strong trend suggests that individuals with more creative achievements displayed more features of nonclinical hypomania than those with fewer creative achievements. Notably, this correlation appeared to be driven primarily by nonscience CAQ scores. Nonscience CAQ scores were positively correlated with HPS scores, $r(92) = .21, p = .04$, while there was not a correlation between science-related CAQ scores and HPS scores, $r(92) < .00, p = .96$ (see Figure 3).⁵ These correlations indicate that higher levels of nonscience-related creative achievement were related to a greater risk for hypomania but levels of science-related creative achievement were unrelated to hypomania.

In contrast, total scores on the ATTA were not significantly correlated with HPS scores, $r(93) = .11, p = .29$, suggesting that divergent thinking ability was not related to risk for hypomania. In addition, none of the subcategories of the ATTA correlated with HPS scores, largest $r = -.10, ps \geq .34$.

Discussion

The current study aimed to further foster a distinction between divergent thinking and a second measure of creativity, creative achievement (the production of tangible or visible pieces), by

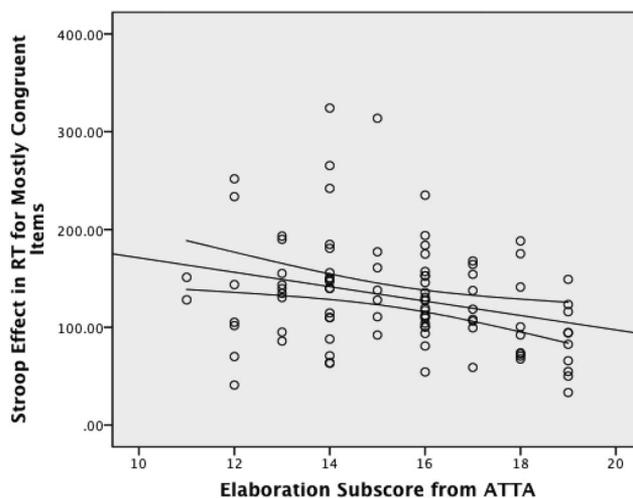


Figure 2. Bivariate correlation between Elaboration subscore from the Abbreviated Torrance Test for Adults (ATTA) and the Stroop effect for mostly congruent items. Note that, for illustrative purposes, the figure excludes one outlier who scored 0 on the Elaboration subscale for the ATTA. Excluding the outlier, the relationship was nominally larger but comparable to that reported for the full sample in the text, $r(92) = -.29, p < .01$.

examining whether these two measures are differentially related to attentional flexibility and hypomania. There were three primary findings, two of which were novel. First, replicating prior research, we found that scores on the measure of divergent thinking (ATTA) and measure of creative achievement (CAQ) were not reliably correlated (Zabelina & Robinson, 2010; Zabelina et al., 2015). Second, using a novel measure of attentional flexibility, we found that divergent thinking was related to the ability to quickly and flexibly bias attention away from a typically distracting stimulus. In particular, higher scores on the Elaboration subscore of the

⁴ Additionally, we followed Zabelina and Beeman's (2013) strategy for ranking low creative achievers (scores between 1 and 8; $N = 31$), medium creative achievers (scores between 9 and 12; $N = 20$), and high creative achievers (scores above 13; $N = 44$) according to total CAQ score, and comparing these groups. A one-way analysis of covariance controlling for age revealed statistically significant differences in HPS scores across creative achievement levels (low, medium, and high), $F(2, 91) = 3.45, p = .04$. Post hoc tests indicated that average HPS scores for the high creative achievers ($M = 16.08, SE = 1.05$) were significantly different than for low creative achievers ($M = 11.95, SE = 1.24, p = .01$); however, average HPS scores for the medium creative achievers ($M = 15.49, SE = 1.56$) did not significantly differ from either the high or low creative achievers, $p = .76$ and $p = .08$, respectively.

⁵ While there was an a priori reason to suspect a difference between science and nonscience CAQ scores in relation to hypomania, for completeness, correlations were also run to examine potentially distinct relationships between these two achievement types and performance on the attentional flexibility measures (i.e., letter naming errors after the switch trial and RT/error rate on the Item-specific proportion congruent Stroop trials). Neither achievement type (nonscience CAQ or science CAQ) was correlated with letter naming errors on trials that followed the cue to switch, $ps \geq .35$. Nonscience CAQ, $r(92) = .23, p = .02$, but not science CAQ, $r(92) = .05, p = .66$, scores were correlated with the magnitude of the Stroop effect in RT for MC items. Neither achievement type was correlated with the magnitude of the Stroop effect for MI items, or with Stroop effects in error rate for either item type, largest $r = .15, ps \geq .15$.

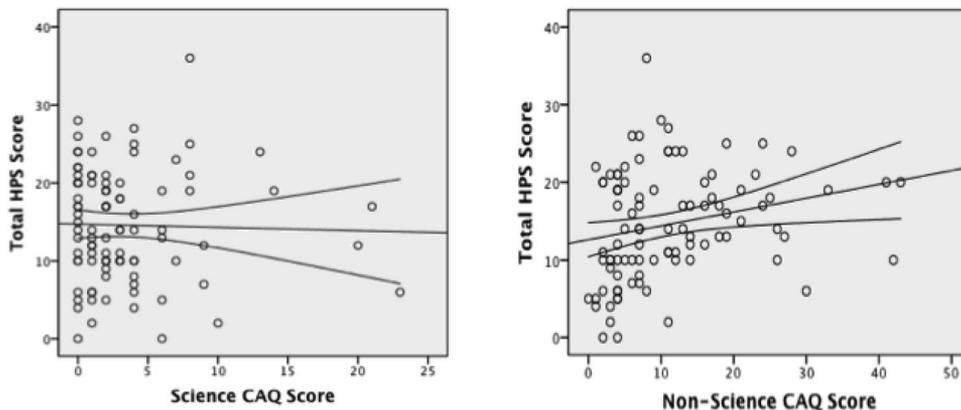


Figure 3. Bivariate correlations between risk for hypomania, as assessed by the Hypomanic Personality Scale (HPS), and science-related (left panel) and nonscience-related (right panel) creative achievement scores from the Creativity Achievement Questionnaire (CAQ).

ATTA were related to better performance (smaller Stroop effect) on mostly congruent items in the item-specific proportion congruence Stroop task. In contrast, higher levels of creative achievement, as indexed by the CAQ, were related to larger Stroop effects for that same set of mostly congruent items.

Borrowing from the ideas of Zabelina et al. (2012, 2015), these patterns may be interpreted as further demonstrating that the attentional biases associated with divergent thinking and creative achievement vary. Divergent thinking appears to be associated with the ability to rapidly overcome prepotent response tendencies (Zabelina et al., 2012), as was necessary when encountering a mostly congruent item presented as an incongruent trial. Divergent thinking also appears to be associated with the ability to effectively filter irrelevant information (Zabelina et al., 2015), and this is further evidenced by the negative correlation between the Flexibility subscore of the ATTA and the magnitude of the Stroop effect for mostly incongruent items (and the generally negative correlations across scores of the ATTA and the magnitude of Stroop effects for both sets of items).

Our findings do not, however, fully converge with those of Zabelina and Robinson (2010), who found that creativity, as measured either by the ATTA or CAQ, was associated with increased flexibility on a Stroop task, as indicated by the Gratton effect. We found that higher CAQ scores were associated with decreased flexibility, as indicated by generally larger Stroop effects across item types, and significantly larger Stroop effects for mostly congruent items. One possibility is that the findings may be reconciled by reinterpreting them based on the susceptibility-as-flexibility logic (Zabelina & Robinson, 2010).⁶ According to this logic, Stroop effects for each item type reflect susceptibility to contextual information as provided by prior experiences with each item type. In this case, a *larger* Stroop effect for mostly congruent items would indicate greater susceptibility to context (and *greater* flexibility) and conversely, a *smaller* Stroop effect for mostly incongruent items would indicate greater susceptibility to context (and similarly, *greater* flexibility). On this interpretation, the larger Stroop effects for mostly congruent items associated with higher CAQ scores imply that creative achievement is associated with greater susceptibility to information provided by prior stimuli (and

greater flexibility), just as the larger Gratton effects for individuals with higher CAQ scores imply greater flexibility. However, for both CAQ and ATTA scores, the correlations (albeit not always significant) were always in the same direction for the mostly congruent and mostly incongruent items, which does not align with the susceptibility-as-flexibility logic. We propose that, as is the case for other individual differences measures (e.g., Kane & Engle, 2003), the mostly congruent condition may be particularly sensitive to individual differences related to attentional flexibility, including those captured by creativity measures, because this condition does not provide contextual (i.e., external) support for the control of attention (away from irrelevant information).

Regarding the second measure of attentional flexibility used in the current study, errors following a switch cue in the letter-naming task, as expected we did not find a correlation between this measure and ATTA scores (see also Zabelina & Beeman, 2013). It remains uncertain, however, why we did not observe a correlation between this measure and CAQ scores. Zabelina and Beeman (2013) found that CAQ scores were associated with an increased tendency to persist in deploying attention toward a previously relevant goal (after an instructed switch), leading to switch costs. The letter-naming task indexed a similar tendency and has been shown in prior studies to be sensitive to variation in ruminative tendencies that are linked to maintenance of goals in the face of a switch (Altamirano et al., 2010), which we had hypothesized to characterize individuals high in creative achievement (cf. Kozbelt, 2008; Zabelina & Beeman, 2013). Future studies are needed to further characterize the relationship between creative achievement and measures of attention. It may be especially informative to employ a task that measures attentional persistence independent of flexibility (e.g., switching) to obtain a “purer” indicator of the tendency to sustain an attentional focus on a single goal. For example, in the mirror-tracing persistence task (see Steinberg et al., 2012), persistence is measured by assessing time spent tracing any given figure using a

⁶ We thank an anonymous reviewer for suggesting consideration of the susceptibility-as-flexibility logic.

mirror, rather than looking at one's hand, before completing that figure or giving up and moving onto a different figure.

A third novel finding was that hypomania was not correlated with divergent thinking but was correlated with creative achievement, and in particular nonscience-related creative achievement. Regarding divergent thinking ability, Zabelina et al. (2014) unexpectedly found that the ATTA was correlated with hypomania in a similar nonclinical sample. The current study did not find evidence for a relationship between the ATTA and hypomania. This finding coheres with the observation that individuals with bipolar disorder do not tend to perform well on divergent thinking tasks, such as the ATTA (Johnson et al., 2012). In contrast, creativity, as measured by creative achievement was positively correlated with hypomania. This correlation approached significance, and an extreme-groups comparison of hypomania in high and low creative achievers (see Footnote 3) converged with Zabelina et al. (2014) in providing statistical support for this relationship. Most interestingly, a novel pattern was found such that there was not a correlation between scientific-related creative achievements (i.e., scientific inquiry, inventions) and risk for hypomania, but there was a significant positive correlation between nonscience-related creative achievements (i.e., visual arts, music) and risk for hypomania, supporting the hypothesis (cf. Carson et al., 2005). These patterns suggest that neither those with strong divergent thinking ability nor those with high creative achievement in science domains are at a greater risk for hypomania; rather, the relationship between creativity and hypomania appears to be driven by high creative achievements in the nonscience (artistic) domain. This converges with the findings that many famous artists have some form of mania and moreover, that individuals specifically in artistic creative occupations (i.e., writers and visual artists), rather than scientists, show signs of mania at higher rates than the normal population (Johnson et al., 2012; Murray & Johnson, 2010). Further, these results provide support for Zabelina and colleagues' (2015) suggestion that creative achievement, but not divergent thinking ability, may be associated with features of psychopathology.

Collectively, the current findings support an expanded measurement of creativity beyond simply assessing divergent thinking ability. Characteristics of thinking divergently are likely not universal to all aspects of creativity, and this may have implications for understanding bipolar disorder. For instance, Johnson et al. (2012) were unable to determine an association between artists and bipolar disorder when assessing performance of individuals with bipolar disorder on measures of creativity, as defined by divergent thinking ability. By contrast, the administration of creative achievement measures (Zabelina et al., 2014), and specifically those that target more artistic achievements as our findings imply, may help identify the missing link that relates aspects of creativity to hypomania and bipolar disorder. Along these lines, attentional flexibility may be one such candidate. It is notable that nonscience-related creative achievement, but not science-related creative achievement, was selectively and positively related not only to hypomania but also to the magnitude of Stroop effects for mostly congruent items (see Footnote 4). Possibly this suggests that attentional inflexibility may explain relationships between artistic achievements and risk for hypomania or bipolar disorder. Future research can inform this possibility by conceptually replicating the novel relationships uncovered herein and examining mediation models that include additional measures of bipolar risk.

Summary of Findings and Limitations

The current findings further highlight the importance of making a distinction between divergent thinking and creative achievement when studying creativity. This distinction was apparent when examining relationships between select measures of attentional flexibility and creativity, and when examining relationships between a measure of hypomania and creativity. In short, divergent thinking, as measured by the ATTA, was associated with greater attentional flexibility on an item-specific proportion congruence Stroop task whereas creative achievement, as measured by the CAQ, was associated with reduced attentional flexibility. The ATTA was unrelated to hypomania but the CAQ was related to hypomania, with greater risk of hypomania most clearly related to higher levels of nonscientific creative achievement. This latter finding may inform future studies that aim to provide insights into the connection between creativity and bipolar disorder, and studies investigating the role of attentional flexibility may be fruitful.

Two limitations merit consideration. First, the above findings were found within a nonclinical population, and may therefore be limited to individuals who have nonclinical levels of hypomania. Thus, future studies are needed to examine such relationships in a clinical population. The knowledge surrounding associations between cognitive inflexibility and bipolar disorder, as well as creative achievement, if confirmed in subsequent studies, could potentially be used to design novel treatment interventions for people suffering from this illness. Second, the current study employed the CAQ and the ATTA to represent creative achievement and divergent thinking, respectively, following Zabelina and colleagues (Johnson et al., 2012; Zabelina & Beeman 2013; Zabelina et al., 2014, 2015; Zabelina & Robinson 2010). However, the observations of Kim (2006) point to the importance of considering alternative measures of creative achievement in future studies. Kim noted that creative achievement, as measured by criteria such as creative achievements during high school, quality of highest creative achievements, and creativeness of the future career one imagines for oneself, has been correlated with divergent thinking, unlike in the current and past studies that have employed the CAQ (Zabelina et al., 2015; Zabelina & Robinson, 2010). Similarly, alternative measures of divergent thinking or alternative scoring techniques for the ATTA, such as the consensual assessment technique, may be employed to evaluate consistency of correlations between divergent thinking, attentional flexibility, and hypomania (see Zabelina et al., 2014).

Conclusion

The current study further supports a distinction between two measures of creativity, divergent thinking ability and creative achievement. These measures are not reliably correlated, and appear to reflect different underlying attentional biases, with divergent thinking ability being positively related but creative achievement being negatively related to the ability to quickly and flexibly overcome relatively automatic and well-learned tendencies that occasionally interfere with attention to goal-relevant information. These measures are also dissociable with respect to their relationships with hypomania. Divergent thinking ability was not related to risk for hypomania but there was evidence for a relationship between creative achievement and risk for hypomania. More specifically, this relationship was driven by artistic creative achieve-

ments, as higher levels of nonscience-, but not science-, related creative achievement were associated with greater risk for hypomania. These relationships may provide insight into how art-making, in particular, is associated with psychopathology and may inform future studies and clinical interventions that further characterize the role of attentional (in)flexibility in psychopathology.

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Received August 22, 2015

Revision received April 27, 2016

Accepted May 3, 2016 ■