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The Relationship between Creativity and Attention in Adults

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Abstract

Creativity is a valuable attribute that involves the generation of original ideas; attention is a vital function that facilitates information selection. There is some evidence that creative people may have poorer attention and are generally more distracted than others, and this distractibility is thought to enable the production of novel ideas. Previous research has largely supported this relationship between creativity and attention, yet they are both multifaceted constructs that can be measured in numerous ways. Using multiple measures of each construct, the aim of this study was to examine which features of creativity and attention might be related in a group of 100 adults (18-80 years, $M = 26.9$, $SD = 11.5$). Figural divergent-thinking (DT) originality was positively related to self-reported concentration; yet no other relationships were found. Results suggest that there is no consistent relationship between creativity and attention, and past studies that linked creativity to attention, having used just one or two measures, may be premature in their conclusions.

The Relationship between Creativity and Attention in Adults

History is littered with illustrations of "creative geniuses" such as Albert Einstein, Charles Darwin, Edgar Allan Poe, and Thomas Edison, who appeared absent-minded, easily distracted, and inattentive, prompting some to examine whether or not creativity and attention may be inversely related. This is by no means clear however, with variation in the definitions and tests used across researchers reducing the persuasiveness of this 'mad-genius' theory (Hyeon, Paek, Abdulla, & Cramond, 2016).

A good start would be with definitions. Creativity is defined as the generation of original, appropriate, useful, and valuable ideas, products, or solutions (Hennessey & Amabile, 2010; Sternberg & Lubart, 1999). Creative behavior may include combining seemingly unrelated ideas to form new solutions (Ansburg & Hill, 2003; Mednick, 1962), the production of multiple responses to a problem (divergent thinking, or DT; Guilford, 1967; Runco, 2004; Torrance, 1966) and the invention of unexpected, novel concepts (Memmert, 2011). Creativity is almost universally deemed a valuable and desirable attribute, especially within the fields of business, sports, the arts, and science.

Attention is defined as the process by which information from our senses is selected for further processing (Broadbent, 1958). This involves the brain directing focus and managing sensory inputs so an individual can process what is important in any given situation. Attention has different forms depending on the activity, and may be focused (i.e., identifying and responding to single items of task-relevant information), sustained (i.e., maintaining focused attention, vigilance, and response consistency over a period of time), selective (i.e., actively selecting and responding to relevant information whilst ignoring distractions and irrelevant stimuli) or divided (i.e., reacting concurrently to the demands of two or more tasks), as described by Bajaj and colleagues (2008). A poor attentional system allows too much irrelevant information to pass through into the limited capacity processor (Vartanian, Martindale, & Kwiatkowski, 2007). This has often been referred to as a 'leaky filter', or as 'broad' attention.

From a review of the (somewhat dated) literature on the relationship between creativity and attention, the main argument appears to be that creative individuals may have this 'broad' or 'leaky' attention. It was proposed that creative people "deployed their attention more widely, were more aware of and receptive and retained more prior stimulus experience in usable form, tending not to screen out the irrelevant" (Dellas & Gaier, 1970, p.55). This implies that although creative individuals took in and processed more irrelevant information, they seemed to be able to manage this successfully, as the information was usable. Dykes and McGhie (1976) established that an ability and inclination to incorporate a broader range of accessible information, and to consider the usefulness of all available data, may be more beneficial to the production of novel and original solutions than the ability to focus attention and to solely concentrate on the problem in hand. Thus, broad attention and distraction allow for more remote, weak, and unusual associations to be made (as opposed to strong associations) by, for example, using the stimuli present in the environment as cues (Carson, Peterson, & Higgins, 2003; Vartanian et al., 2007). Indeed, empirical studies have supported this assertion.

It has been found that those with broad attention were more likely to make remote, original associations between the stimuli that were distracting them, whereas those with a narrow focus of attention were less likely to spot these opportunities (Ansburg & Hill, 2003; Friedman, Fishbach, Forster, Werth, 2003; Kasof, 1997; Necka, 1999; Vartanian et al., 2007). In studies evaluating the use of peripheral cues in the solution of anagrams, participants who had high creativity scores used more of the environmental cues than low creativity scorers (Ansburg & Hill, 2003; Dewing & Battye, 1971; Mendelsohn & Griswold, 1964). Creativity was measured in these studies by the Alternate Uses Test (Dewing & Battye, 1971) and the Remote Associates Test (Ansburg & Hill, 2003; Mendelsohn & Griswold, 1964).

Using dichotic listening tests as a measure of selective or divided attention, high creativity scorers (as assessed by the Wallach & Kogan (1965) Tests of Creative Thinking) reported

significantly more information from the irrelevant listening channel (Dykes & McGhie, 1976), and made more errors (Rawlings, 1985) than those low on creativity. In a visual search task measuring selective attention, highly creative participants, as estimated by a DT task, made more errors than the less creative participants (Necka, 1999). The attention scores of the creative people worsened as the number of irrelevant stimuli increased, perhaps showing that they were less able to separate relevant information from the irrelevant (Necka, 1999).

Further evidence for a deficit in selective attention amongst creative individuals was found when high scorers on the Creative Achievement Questionnaire (CAQ: detailed by Carson, Peterson, & Higgins, 2005) had significantly lower selective attention scores (Carson et al., 2005), and significantly lower latent inhibition scores (Carson et al., 2003). This meant that they were less able to filter out from awareness stimuli that had already been regarded as irrelevant. A reduction in latent inhibition may be the key to the creation of original ideas, as there is an increased opportunity to combine unrelated concepts to produce novel ideas (see also Zabelina, O'Leary, Pornpattananangkul, Nusslock, & Beeman, 2015). This indicates that broad attention may be crucial for creativity, as the highly creative individuals were seven times more likely than low creativity scorers to have broad, uninhibited attention (Carson et al., 2003).

Additionally, Vartanian and colleagues (2007) found that when there were no distracting stimuli, creative individuals (as measured by an Alternate Uses Task and a Remote Associates Task) had faster reaction times (RTs) to the appearance of a light, and faster rule comprehension times, than non-creative people. Conversely, when in-task response inhibition (selective attention) was required in the presence of irrelevant cues, creative participants had slower RTs, indicating that they were distracted by, paid more attention to, and therefore processed the irrelevant information more than the non-creative group.

Although there is research showing a link between creativity and broad attention, that this is a fixed 'trait' is controversial (e.g., Dewing & Battye, 1971; Eysenck, 1995; Kasof, 1997; Mendelsohn, 1976; Necka, 1999). The problem lies in the development of potential ideas. For example, broad attention is suited to producing creative and novel ideas (by making remote associations), but broad attention would be a problem when the ideas need to be evaluated and honed for their relevancy (Martindale, 1999). Therefore some authors indicate that a fluctuation with narrow attention is also required for creativity and idea elaboration (e.g., Ansburg & Hill, 2003; Dykes & McGhie, 1976; Friedman et al., 2003; Martindale, 1999; Vartanian et al., 2007).

Creativity and attention have typically been measured previously using just one or two tasks for each, arguably this may not accurately represent the complexity of each construct. For example, the majority of the work in this area has focused on selective attention and response inhibition. In order to understand the possible relationship more thoroughly, it is important to encompass a broader conceptualization of both creativity and attention, by using a range of assessment methods. The research presented here will accomplish this by measuring the relationship between creativity and attention using numerous tests for each construct, including self-report and performance measures. Specifically, creativity was measured by self-report self-efficacy and past creative achievement, verbal and figural DT, and the production of a collage. Attention was assessed with a self-report questionnaire, as well as performance measures of focused, sustained, selective, and divided attention.

It was hypothesized that a relationship would exist between several aspects of creativity and attention, in that as creativity scores increase, attention scores decrease (e.g., Carson et al., 2003; Finke, Ward, & Smith, 1992; Kasof, 1997; Memmert, 2011; Vartanian et al., 2007).

Methods

Design

Each participant completed all of the tasks of creativity and attention. Within-group correlational analyses were carried out to determine if relationships existed between creativity and attention. The dependent variables (DVs) were the scores from the multiple creativity and attention tests. Creativity DVs were self-report self-efficacy and creative achievement scores, DT fluency, originality, elaboration (figural test only), and flexibility (verbal test only), and scores on the production of a collage. Attention DVs were self-report attention scores, and scores on tests measuring focused, sustained, selective, and divided attention.

Participants

One hundred participants (79 females, 21 males) took part, with ages ranging from 18 to 80 years (M = 26.9 years, SD = 11.5 years). In relation to sample size, the statistical power of this study was calculated post-hoc using a medium effect size (0.5) in G*Power (Faul, Erdfelder, Lang, & Buchner, 2007), showing a high result of .99.

Participants were recruited via the Edinburgh Napier University voluntary participant pool, internet advertisements on social media and community websites, and with posters around the university.

This study was granted ethical approval by the Faculty of Health, Life, and Social Sciences Research Integrity Approvals Group at Edinburgh Napier University.

Materials

Six tests of creativity and five tests of attention were used.

Preliminary Questionnaire. Questions regarding an individual's gender, age, and self-reported creativity and attention were combined into one 13-item questionnaire for the purpose of this study.

The first test of self-report creativity was a creative self-efficacy measure. Creative self-efficacy is someone's own self-belief and judgements about their own creativity (Kaufman, Plucker, & Baer, 2008; Tierney & Farmer, 2002). This is important here as those with high self-efficacy are more likely to gear their behaviour towards fulfilling a specific goal as they believe they can achieve this, whereas those with low self-efficacy are likely to envisage failing to achieve, and will therefore place obstacles in their way (Bandura, 1993). It has been stipulated that strong self-efficacy in this context is essential for creative production, motivation, and the ability to behave creatively (Bandura, 1997; Tierney & Farmer, 2002). A measure of creative self-efficacy was included here to gain understanding of the participants' valuation of creativity in their everyday lives, and to determine if this particular mind-set, or predisposition to be creative, is related to attentional capacity.

Creative self-efficacy was measured in this research by combining the items from two established questionnaires, by Beghetto (2006) and Jaussi, Randel, and Dionne (2007). The three questions from Beghetto (2006) allude to the act of being creative, in relation to the production of ideas. Alternatively, the four questions by Jaussi and colleagues (2007) refer to the effect that creativity has on the individual, in terms of who they are as a person, and how important creativity is to them. The two questionnaires were combined here as they each measured creative self-efficacy in a different way.

Example statements include: 'I am good at coming up with new ideas' (Beghetto, 2006), and 'My creativity is an important part of who I am' (Jaussi et al., 2007). The statements were answered with a five-point Likert scale ranging from 'strongly disagree' (one point) to 'strongly agree' (five points), with a 'neither agree nor disagree' (three points) option included. One total score was taken representing creative self-efficacy. The creative self-efficacy scale had a high reliability rating with a Cronbach's alpha of .874.

Self-reported attention items within the Preliminary Questionnaire were created by the researcher as no measure was found to exist that allowed participants the opportunity to show how they judged their own abilities in concentrating and focusing on tasks. The questions asked the individual to judge some of their own attentional abilities and were scored in the same way as above. An example item is: 'I am easily distracted' (reversed scoring). This self-report attention scale had an alpha of .847, showing high inter-item reliability.

Two scores were calculated per participant from the Preliminary Questionnaire: a creative self-efficacy total score, and a self-report attention total score.

Creative Achievement Questionnaire. The CAQ (Carson et al., 2005) provided individuals with the opportunity to disclose their achievements in ten domains: visual arts, music, dance, architectural design, creative writing, humor, inventions, scientific discovery, theatre and film, and the culinary arts. The CAQ makes it easy for researchers to compare individual or group differences in past creative achievement, and allows for a distinction to be made between those who are creative in one domain and those who are creative across many (Carson et al., 2005; White & Shah, 2011).

For each creative domain, participants select from eight statements those that applied to their achievements. The first statement was always 'I have no training or recognized talent in this area', which scored zero. The statements then progressed from 'I have taken lessons in this area' scoring one point, to 'my work has been critiqued in national publications', which scored seven points and requested an estimate of the number of times this had occurred (points were then multiplied by the number of times; Carson et al., 2005). The scores were added to make a single total CAQ score for each participant. The CAQ has been found to be valid and reliable with test-retest scores of $r = .81$, $p < .001$, and an internal consistency score of Cronbach's alpha = .96 (Carson et al., 2005). Carson et al. (2005) also determined that performance on this

measure was related to higher creativity scores for an artistic item produced by participants ($r = .59$, $p < .001$), and to divergent thinking scores ($r = .47$, $p < .001$).

Divergent Thinking (DT) Tasks. Two tasks tested the production of written responses, or verbal DT, and a third tested figural DT, which required drawn responses. Verbal DT was measured by the Unusual Uses Tasks (UUT) taken from the Torrance Tests of Creative Thinking (TTCT: Torrance, Ball, & Safter, 1992), where participants were required to list as many ideas as possible for unusual uses of everyday objects (in this case, a tin can and a cardboard box). Each verbal DT task was scored for fluency (total number of responses), flexibility (number of types of ideas), and originality (uncommon responses; Torrance, 1990). As both UUTs measured the same construct (verbal DT), scores from both tests were combined to give overall fluency, flexibility and originality scores for each participant.

To measure figural DT, the Circles task from the TTCT was used. Participants were given worksheets with rows of small, simple circles. The instructions were to draw as many different objects or pictures incorporating the circles as possible, using only a pen. Fluency and originality scores were allocated in the same way as described above. Flexibility was not accounted for in this task, as ideas are limited to the shape of the circle. Instead, points were awarded for elaboration (according to the instructions by Torrance et al., 1992), such as the joining of more than one circle for one idea, or adding details.

Each DT task had a five-minute time limit. The original DT tasks set by Torrance lasted ten minutes each, however, times have varied throughout studies. It has previously been argued that five minutes is an optimal time for this type of task, so this time limit was used in this case (Snyder et al., 2004). The TTCT battery in particular has had empirical support from a range of studies, with test-retest reliability scores having varied from .50 to .93 (Torrance 1966; 1974), which is a large range but in favor of the tests. It has been stressed that this range was due to the complexity of creative performance (Kim, 2006). A longitudinal study found

evidence of predictive validity, when the TTCT was completed seven years after it was initially carried out by the participants, with scores on the three divergent thinking scales (fluency, flexibility, and originality) being moderately, positively related to real life creative achievement (r = .39 to .48, p < .01; Kim 2006).

Creative Production: Collage Task. Participants were asked to make a collage from paper (29.7 × 42.0cm) and numerous craft items, and instructed to (1) be as creative as possible, and (2) produce something that others may not think of. This method has been used extensively in previous research assessing creativity (e.g., Amabile, 1982; Amabile, Hennessey, & Grossman, 1986). The Consensual Assessment Technique (CAT) developed by Amabile (1982), was used to score the collages. Seven extra participants with expertise in an area of visual art or design volunteered to be judges, five were recruited from the School of Creative Industries at Edinburgh Napier University, and two were artists and interior designers known to the researcher.

The collages were presented to the judges anonymously, and they were shown the exact materials that the participants had had available to make their collages. Each judge used their own understanding of creativity to independently score each of the 100 collages on a scale from one to ten, relative to the other collages. The mean score became the overall collage score (Kaufman et al., 2008). Following the recommendation by Amabile (1996), a two-way random intra-class correlation was conducted to determine inter-rater consistency. A great degree of consistency was found between the judge's ratings. The average measure intra-class correlation was .693 with a 95% confidence interval from .612 to .763 (F(149, 894) = 3.262, p <.001).

Focused Attention/Attentional Control: Attentional Blink - Rapid Serial Visual Presentation (RSVP) task. An attentional blink rapid serial visual presentation (RSVP) computer task was used with E-Prime 1.0. An attentional blink occurs when the identification of a second pre-specified target (T2) is unknowingly missed by the participant if it appeared

within 500ms of the first known target (T1) (Di Lollo, Kawahara, Shahab Ghorashi, & Enns, 2005; Shapiro, Arnell, & Raymond, 1997). It is thought that the attentional blink could be caused by a brief break in visual control after viewing T1, whilst attention switches strategy to prepare for the processing of T2 (Di Lollo et al., 2005). This task therefore measures the participant's ability to switch and control attention.

This test is described in full elsewhere by those who designed it: Shapiro, Raymond, and Arnell (1994). The task consisted of 32 trials, each containing a rapid sequence of 24 uppercase black letters ('courier new' font, size 18) presented in the middle of a grey screen. The stream of letters lasted between 2 and 2.4 seconds, and each letter was presented for 15ms followed by a 75ms blank pause. The task was to detect the one white letter within the sequence, which the participants knew would be a B, G, or S (T1). The white letter was the cue to look for T2, a black letter X, which was presented on 50% of trials. Following each sequence, the task required the participants to indicate whether they had seen a B, G, or S in white, which they answered by pressing the corresponding key on the computer's keyboard. Immediately after this, the question 'was the letter X present following the presentation of the target B, G, or S' was presented on screen, and participants pressed the 1 key for 'yes', or 2 for 'no'. The measures gained from this task were T1 and T2 detection accuracy as a percentage.

Sustained Attention: Continuous Performance Task (CPT). CPTs are a measure of sustained attention, as participants are asked to maintain concentration for a relatively long period of time, to a mundane, repetitive task. The visual CPT as fully described by Shalev, Ben-Simon, Mevorach, Cohen, and Tsal (2011) was used and presented using E-Prime 2.0. Participants were asked to react only to a red square stimulus (target) by pressing the spacebar, whilst ignoring all other stimuli. Of the 320 timed trial presentations, the target was presented 96 times (30% of trials). The whole CPT lasted approximately 12 minutes, therefore measuring

the participant's ability to remain attentive to one repetitive task over a reasonably long period of time.

The main score for this task was mean RT across the length of the task, and this was used in analysis of sustained attention. The number of omissions (targets missed by participant) and commissions (an alternative stimulus mistakenly being identified as the target) were also extracted for analysis. Specifically, omission errors are thought to be indicative of inattention, and commission errors are said to be representative of impulsivity (e.g., Marchetta, Hurks, De Sonneville, Krabbendam, & Jolles, 2007).

Selective Attention and Response Inhibition: Stroop Task. To measure the participants' ability to select relevant information and ignore the irrelevant (selective attention), they performed the color-word Stroop task (Stroop, 1935). The task used software program CogLab 3.0.

The computer screen was black, and the word 'red', 'green', or 'blue' ('arial' font, size 18) appeared one at a time in the center, above a small fixation dot. The words either appeared in their congruent color (i.e., the word *green* written in green) or an incongruent color (i.e., the word *green* written in red). Participants had to identify the color of the font only, whilst ignoring the word itself, by pressing the assigned key. As previous studies have shown, it is likely that the mean RT for incongruent trials would be higher than for congruent trials (Kane & Engle, 2003), due to the conflicting information presented on screen, thus taking the participant longer to process.

In total there were 45 trials, 15 of which were congruent, and 30 of which were incongruent. In analysis, the mean congruent RT was subtracted from the mean incongruent RT to determine the extent of the difference between the conditions.

Divided Attention: Dual-Tasking. The dual-tasking measure examined the participant's ability to carry out two tasks simultaneously, which measures divided attention and attentional

control (Della Sala, Foley, Beschin, Allerhand, & Logie, 2010). Participants completed a paper and pencil based task, as fully described by Della Sala and colleagues (2010), where they were required to repeat lists of digits back to the researcher, whilst tracing a simple maze with a pen. First, participants' digit span was determined, followed by a digit list memory task. They then performed a maze tracing task, and then completed both the number list memory and maze tasks simultaneously.

The four raw scores per participant (single-task digit list accuracy, dual-task digit list accuracy, single-task maze score, and dual-task maze score) were transformed using the formulae provided by Della Sala et al. (2010), in to a score of proportional performance, combining the scores from each part. With this calculation, a score of 100 would indicate no effect of the dual-task condition, above 100 would highlight a performance improvement, and below 100 shows a performance deficit in the dual-task condition.

Procedure

The testing session lasted between 80 and 90 minutes and each participant was tested individually. Beforehand, participants read an information sheet and signed a consent form. After any questions had been answered, the Preliminary Questionnaire and the CAQ were administered. These were provided at the beginning of the session to avoid the participants' own perceptions on their performance during the testing to affect how they answered the questions.

To allow participants to habituate to the testing environment, a three minute warm-up task was supplied, which consisted of a picture construction task (from Torrance et al., 1992). This task was not scored, and was used for acclimatization purposes only. The order of the remaining tasks was pseudo-randomized to reduce order effects. Breaks of one to two minutes were offered to participants between each task, although these were generally rejected. At the end of

the session, participants were encouraged to ask any questions they had, thanked, and were given a debrief sheet to take away with them.

Results

Table 1 contains the descriptive statistics for each of the creativity and attention measures used, including the minimum, maximum, mean, and standard deviation values.

As a large number of statistical tests were calculated, the probability of reporting a type I error increased. For this reason, only results with a probability value of less than .01 were further considered in the discussion, following the recommendation by Howell (2007).

Table 2 shows the Pearson correlations (Spearman correlation used for CAQ measure only) between all of the creativity and attention measures. There was only one significant relationship ($r = .27$, $p < .01$): between figural divergent thinking originality and self-report attention, where higher originality scores were related to higher levels of concentration. There were no other significant correlations.

In order to demonstrate that each of the creativity tests used measured something different, correlations are presented in table 3 showing the relationships between performance scores on each task. There are a number of significant correlations ($.21 < rs < .91$, $p < .01$) between the divergent thinking tasks, but these trends did not extend to the self-report and collage scores.

Similarly, table 4 illustrates the correlations between each attention measure. There are fewer significant correlations here, with the only across test correlation ($r = .28$, $p < .01$) between T2 attentional blink accuracy and dual-task score.

Supplementary analysis involved conducting canonical correlations, with the attention measures as set one, and the creativity measures as set two, to determine if the construct of attention (as measured here) could predict the construct of creativity (as measured here). The

full model was non-significant, with Wilk's λ of .515, $F(63.00, 569.31) = 1.13$, $p = .238$ indicating that further scrutiny of individual canonical functions was not necessary.[1]

Discussion

It was hypothesized that there would be a relationship between creativity and attention, and that creativity scores would increase as attention scores decreased. Ultimately, this hypothesis has not been supported. There was one significant relationship ($r = .27$, $p < .01$) found between measures of creativity and attention, as figural DT originality was positively, weakly related to self-report concentration levels (as measured by the Preliminary Questionnaire). This was not the direction of relationship expected. It could possibly be that focus is required to produce original, creative responses in the figural DT task, but this proposition is tenuous given the poor strength of the correlation coefficient, and given that no other relationships were found to support this.

This study does not show support for the literature reported here that has found a link between creativity and poorer attentional control (e.g., Vartanian et al., 2007), selective attention (e.g., Ansburg & Hill, 2003; Dykes & McGhie, 1976; Kasof, 1997; Necka, 1999), and divided attention (e.g., Rawlings, 1985). According to previous reports, broad, diffused attention is beneficial for creativity, and narrow attention is not (Kasof, 1997). This is because the nature of distraction allows individuals to combine and generate solutions to problems that may be missed by those who focus solely on the task in hand (Abraham & Windmann, 2007; Carson et al., 2003; Vartanian et al., 2007). However, the opposing argument is that narrow attention is also required to enable the development, elaboration, and refining of creative solutions (Martindale, 1999; Wallas, 1926). Given that broad (or indeed narrow) attention does not appear to be the crucial construct required to influence creativity here, it may be that

[1] Similarly, the data assumptions for factor analysis were not met, and regression analyses were inconclusive.

correlational analyses on the measures used within this study would not identify an attentional switch. Further scrutiny did not highlight a requirement for further statistical testing for non-linear relationships here, but future studies could be purposely designed to test for this.

The primary concern in consideration of previous studies was that researchers may have been optimistic in their claims of finding a relationship between the two complex constructs of creativity and attention, having only measured them with one test each. In support of this, an examination of the correlations presented in table 3 determines that the two self-report measures of creativity are related, and the verbal and figural DT scores are related, but there are no relationships across the self-report, divergent thinking, and collage measures. This shows that each test may be measuring a different aspect of creativity, and that the results from one test cannot be generalized to represent creativity as a whole. Similarly, as shown in table 4, there is only one relationship between the attention measures (RSVP T2 accuracy and Dual-Task score), again indicating that the tests were not all measuring the same thing, but different facets of attention. This was a thorough study that aimed to clarify and strengthen previous findings by using a comprehensive set of tests representing the multifaceted nature of each construct. It can only be determined here, that within this group of participants, and with the measures used, creativity and attention are not related to each other.

This somewhat underwhelming conclusion questions the role of attention in creativity, if there is a role at all. In consideration of the theoretical understanding of the cognitive processes involved in creativity, attention does not appear to be a cognitive function that is essential for creative performance. This rebuts a somewhat logical assumption that relationships may have been expected, if only due to the management of each construct by executive function (EF). For example, the divergent thinking tasks, and the sustained, selective, and dual-task attention measures were all timed, meaning they all have similar pressures, and may perhaps then involve similar functions (e.g., organization, time-management, memory, planning). Indeed,

significant relationships have been found between creativity and aspects of EF (e.g., Scibinetti, Tocci, & Pesce, 2011; Sharma & Babu, 2017). Alternatively, other aspects of cognitive functioning may be important for creativity, such as working memory, or mental imagery. Factors such as fluency and flexibility could arguably require the use of EFs such as working memory and organization, but originality may be less reliant on EFs. It could be that EF is still the common factor in both constructs, but perhaps creativity is related to higher EFs and EF capacity (e.g., Benedek, Franz, Heene, & Neubauer, 2012; Bott et al., 2014; Gilhooly, Fioratou, Anthony, & Wynn, 2007; Van Stockum & Decaro, 2014) rather than attention specifically.

There are two key limitations that may have affected the results: ecological validity, and participant bias.

Ecological validity is arguably a prominent problem in all studies that use laboratory based experiments to test human behavior and cognitive processes. More consideration needs to be made in the future for the use of ecologically valid measures of creativity and attention to improve generalizability. Future research could investigate the effect of attention on creativity in those established within creative fields, and/or could compare those high in creativity to those low, as this may help to further examine the relationship between creativity and attention in real life.

As for participant bias, the materials used in the recruitment process of this research advertised a study investigating creativity and attention, and specified that participants 'need not be particularly creative to take part'. Accordingly, a score of 14 or less on the creative self-efficacy questionnaire would indicate that an individual had no interest in, or had no desire to be creative. Only two of the 100 participants scored below 14, so the participants of this study regarded themselves as creative people. It is possible that the disparate results could be related to a bias within the participant pool.

The study presented here was a robust exploration of the relationship between creativity and attention. Many measures were used with the aim of comprehensively studying these broad constructs, and it has been made clear that there is not a demonstrable, overarching relationship across creativity and attention in the measures here used. Importantly, it has been determined here that creativity and attention are complex constructs that cannot and should not be represented by just one measure. To further our understanding of the effect of cognitive abilities on creativity, if there is such an effect, it is necessary to depart from investigating attention, and instead examine alternative cognitive processes (such as executive functions, working memory, imagination) and possible mediating factors.

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Tables

Table 1: Minimum, maximum, mean, and standard deviation values for each measure used.

	Measure	Minimum	Maximum	Mean	Std. Deviation
Creativity Tasks	Self-report				
	Creative self-efficacy	10	35	24.47	5.02
	Creative Achievement	0	64	11.08	12.56
	Unusual Uses Task				
	Fluency	2	60	24.27	10.08
	Flexibility	2	35	16.84	5.89
	Originality	0	31	8.88	5.58
	Circles Task				
	Fluency	0	25	8.62	4.54
	Originality	0	10	3.49	2.21
	Elaboration	0	10	3.51	2.23
	Collage Score	2.71	7.71	5.06	1.06
Attention Tasks	Self-report attention	4.00	19.00	12.86	3.49
	Attentional Blink Task				
	Target 1 Accuracy (%)	31.25	100.00	93.25	9.33
	Target 2 Accuracy (%)	37.50	87.50	65.41	11.09
	Continuous Performance Task				
	Reaction time (ms)	346.19	567.53	441.32	45.54
	Omission errors	0.00	11.00	0.71	1.67
	Comission errors	0.00	8.00	0.30	0.92
	Stroop Task	-741.67	839.93	83.95	198.47
	Dual Task	60.52	128.85	97.55	11.39

Table 2: Correlations between the creativity and attention measures.

Measure	Creative self-efficacy	CAQ[a]	Unusual Uses Task			Circles Task			
			Fluency	Flexibility	Originality	Fluency	Originality	Elaboration	Collage
Self-report attention	.14	.14	-.05	-.00	.03	.22	**.27****	.22	.00
Attentional Blink RSVP Task									
Target 1 accuracy (%)	-.03	.04	-.06	.02	-.02	.11	.13	.14	-.21
Target 2 accuracy (%)	-.05	-.00	-.07	-.08	-.22	.13	-.07	.02	-.16
Continuous Performance Task									
Mean RT	.00	.03	-.12	-.04	-.16	-.22	-.24	-.24	-.01
Omission Errors	-.11	-.08	-.09	-.09	-.18	-.16	-.18	-.10	.00
Comission Errors	-.05	-.01	-.01	-.07	-.04	-.05	-.02	.08	.06
Stroop Score	-.09	-.25	-.05	-.03	-.06	-.04	-.10	-.02	.04
Dual-Task Score	.10	-.04	.02	.10	.12	.17	.00	.10	-.10

** indicates $p < .01$. [a] indicates that Spearman correlations were reported for the CAQ task as the data were non-parametric.

Table 3: Performance correlations between the creativity measures.

	1	2[a]	3	4	5	6	7	8

	Self-report							
1	Creative self-efficacy							
2	Creative achievement[a]	.40**						
	Unusual Uses Task							
3	Fluency	.02	.14					
4	Flexibility	.00	.10	.91**				
5	Originality	.03	.18	.83**	.81**			
	Circles Task							
6	Fluency	.09	.10	.37**	.36**	.29**		
7	Originality	.19	.22	.23*	.21	.27**	.62**	
8	Elaboration	.21	.07	.31**	.29**	.24	.51**	.54**
9	Collage	.18	.03	.18	.18	.19	.03	-.01	.12

** indicates $p < .01$. [a] indicates that Spearman correlations were reported for the CAQ task as the data were non-parametric.

Table 4: Performance correlations between the attention measures.

		1	2	3	4	5	6	7
	Self-report							
1	Attention							

	Attentional Blink RSVP Task														
2	Target 1 accuracy (%)		.09												
3	Target 2 accuracy (%)	-	.10		.35**										
	Continuous Performance Task														
4	Mean RT	-	.11	-	.17	-	.10								
5	Omission Errors	-	.03	-	.15	-	.10		.12						
6	Comission Errors	-	.13		.04		.10	-	.22		.36**				
7	Stroop Score		.04		.02		.19	-	.15	-	.15	-	.05		
8	Dual-Task Score		.10		.22		.28**	-	.11		.09		.15		.09