

CREATIVITY, FLEXIBILITY AND AGING

By

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ABSTRACT

Cognitive flexibility refers to the ability to switch between tasks, concepts, or strategies. It is a fundamental element of executive functioning and has been shown to be positively associated with creativity. Past studies have demonstrated that cognitive flexibility may increase accessibility to creative ideas through inhibiting fixating thoughts and promoting perspective switching processes. Despite substantial evidence that cognitive abilities decline with age, recent research suggests that creativity may remain stable in adulthood. Further, it may be an important factor in successful aging. While the relationship between aging and creativity is not fully understood, evidence suggests that engagement in creative activities during later life is associated with more positive outcomes. The current study aims to prime cognitive flexibility with a divided attention task in order to increase creativity in younger and older adults. The divided attention task consisted of a go/no-go task and spatial attention task. Creativity was measured using the Abbreviated Torrance Test for Adults (ATTA). A two-way ANOVA was conducted to assess creativity based on the priming task and age group. While there were no significant results, it was revealed that young adults were slightly more creative than older adults. Similarly, those in the experimental condition displayed slightly more creative ability compared to those in the control condition. However, more research is needed to fully elucidate the relationship between creativity, cognitive flexibility, and age.

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INTRODUCTION

Creativity

As an integral element to the human experience, creativity has become a popular topic in psychological research. Creativity is usually associated with the arts; however, it can be found across various fields including, science, technology, business, and activities of daily living (Gaut, 2010). Prior research has proposed at least a hundred definitions of creativity and countless ways to operationalize the construct (Said-Metwaly et al., 2017; Barbot, 2019). Runco & Jaeger (2012) presented a definition of creativity, which is widely considered as the ‘standard definition’ in the social sciences. It states that for an idea to be creative, it must be both original and useful. By this definition, an idea can be novel, but not useful, and therefore, not creative. For example, an old tire could be used as a flowerpot or a parachute. While both of these uses may be novel, one is clearly more useful than the other (Diedrichetal et al., 2015).

Creativity is abstract; it is always changing and developing. As a consequence, it is difficult to measure, and there has been a lot of discourse on the topic. Factors such as the definition, what aspects should be valued, and what instruments should be used need to be considered when measuring creativity (Said-Metwaly et al., 2017). Several features are commonly used to assess creativity in research: performance, achievement, and potential.

Creative performance can be defined as the production of ideas, products, or procedures that are novel and useful (Zhou & Oldham, 2001). Creative achievement is the sum of creative products generated by an individual in the course of their lifetime

(Carson et al., 2005). Creative potential is a little more ambiguous. It is a latent construct concerned with one's ability to produce original work (Walberg, 1988; Lubart et al., 2013). Prior research suggests that creative potential, as assessed by divergent thinking (DT) measures, is a good indicator of future creative performance (Runco & Acar, 2012).

Divergent thinking typically focuses on the generation of original ideas. This can be contrasted with convergent thinking, which focuses on a 'correct' answer. Although the validity and practicality of DT tests have been called into question, DT tests remain among the most commonly used when assessing creativity (Zeng et al., 2011). It is important to note that divergent thinking is not equivalent to creative thinking, it is simply an indicator of future creative thinking (Runco, 2008; Runco & Acar, 2012).

Fixation

Old ideas and prior knowledge may impede the ability to produce new ideas and appropriate solutions (Storm & Hickman, 2015). This is a phenomenon known as mental fixation. Prior research has identified several methods for overcoming a fixation. The ability to subdue irrelevant concepts and ideas is critical for performance on creative tasks (Storm & Angello, 2010). For example, an incubation period, or time spent away from the problem, has been shown to allow participants to forget whatever thought or association is causing the fixation (Smith, 1995). There are two prominent theories to explain the mechanisms involved in the incubation effects: the spreading activation and the selective forgetting hypotheses. Spreading activation posits that during an incubation period, activation will spread to related concepts and, as a result, sensitize an individual to relevant information (Sio & Rudowicz, 2007). The selective forgetting hypothesis suggests that irrelevant information will be desensitized during the incubation period.

(Valueva & Lapteva, 2020). There does seem to be substantial empirical support for beneficial effects of an incubation period. However, several recent studies suggest that these benefits will only occur after one has been misdirected or is already fixated (Valueva & Lapteva, 2020; Vul & Pashler, 2007).

Cognitive Flexibility

Cognitive flexibility – the ability to switch between different concepts, tasks, or strategies – is a crucial aspect of effective executive functioning. It allows individuals to adjust their behavior and adapt to a constantly changing environment. (Buttelmann & Karbach, 2017). Further, increased cognitive flexibility is associated with more positive outcomes across the lifespan (Dajani & Uddin, 2015). There is evidence to suggest that cognitive flexibility plays a role in creativity. For example, Carson et al. (2005) found cognitive flexibility to be positively associated with creative achievement. It has also been found that concentrative meditation increases creative performance by enhancing cognitive flexibility (Müller et al., 2016). Zabelina & Robinson (2010) suggested that creative individuals are those who are able to switch between processing modes in a manner best suited for the present context. Other studies have demonstrated the importance of cognitive flexibility in creativity through task switching. Such studies suggest that task switching may facilitate the (1) inhibition of fixating ideas and (2) perspective switching process, allowing for increased accessibility to creative ideas. (Lu et al., 2017; George & Wiley, 2019). Recent research suggests that cognitive flexibility can be conditioned by simple rewards or triggered by contextual clues (Braem & Egner, 2018). For example, it has been shown that cognitive flexibility can be altered by factors

such as meditation (Moore & Malinowski, 2009; Müller et al., 2016), exercise (Masley et al., 2009; Mekari et al., 2020), or emotional states (Lin et al., 2014; Wang et al., 2017).

Aging and Creativity

Attitudes towards aging have shifted in the last 50 years. Aging was once thought to be an inevitable decline into senility, until a fundamental conceptual change brought forth hypotheses that described the decline as age-related problems of modifiable disorders (Cohen, 2006). Since this shift in perspective, the term ‘successful aging’ has gained popularity. Successful aging is multidimensional, accounting for physical, psychological, and social functioning in old age without any major diseases (Urtamo et al., 2019). In a qualitative study, Fisher & Specht (1999) identified six features of successful aging: a sense of purpose, interactions with others, personal growth, self-acceptance, autonomy, and health. It has been found that creative engagement in later life may contribute to these features by promoting independence and a sense of control over one’s life (McFadden & Basting; 2010). Noice & Noice (2009) found perceptions of personal growth to have significantly increased after older adults participated in a 4-week performing arts intervention. Kinney & Rentz (2005) observed an increase in interest, pleasure, self-esteem, and normalcy in individuals with early to mid-stage dementia after engaging in visual arts activities when compared to others engaged in more traditional adult day center activities.

Age-related changes in creativity are not well established. Several theories suggest that creativity reaches its peak in one’s 30s and declines by their 40s (Lindauer et al., 1997). However, a recent study found that creativity remains stable through middle adulthood, despite a large body of evidence suggesting cognitive decline in older

adulthood (Lamancusa et al., 2019). In fact, creativity may even be important for successful aging. The Creativity and Aging Study aimed to evaluate health effects of older adult participation in cultural programs. Data outcomes from this study found that community-based cultural programs that emphasize creativity seemed to reduce risk factors that contribute to the need for long-term care (Cohen et al., 2006). Moreover, because aging can be viewed as a long-term stress and coping process, creativity may facilitate successful aging by enabling older adults to more effectively adapt to the physical, psychological, and social demands placed on them through their lifespan (Baltes, 1987; Flood & Phillips, 2007). Carpentieri et al. (2017) found that older adults who engage in activities aiming to maximize the gains and minimize the losses associated with the daily demands of later life are more likely to have higher rates of well-being despite low levels of physical function.

The Present Study

This study is addressing two main questions. Firstly, can cognitive flexibility be primed with a divided attention task and facilitate creative thinking by overcoming fixation? Several studies have facilitated creative thinking by enhancing cognitive flexibility (Ritter et al., 2012; Ritter & Mostert, 2017). Positive affect (Wang et al., 2017; Emich & Pyone, 2018) and global (vs. local) processing (Dreu et al., 2011) have been used to prime cognitive flexibility in the past. However, using a divided attention task to prime cognitive flexibility is a somewhat novel and exploratory method. Cognitive flexibility hinges on several factors including attention, workload, and individual differences in one's ability to notice changes in environmental stimuli (Figuroa & Youmans, 2011). The divided attention task in this study requires participants to

simultaneously complete a go/no-go and spatial attention task. In order to perform the task successfully, participants have to effectively provide responses using two rule sets. Secondly, this study aims to examine the consistency of potential priming effects across the lifespan, specifically through the inclusion of an older adult sample. We hypothesized that successful priming with the divided attention task will occur in the younger adult group, indicating a release from fixation and facilitating creativity. It is also possible that we will observe successful priming in the older adults, though we did not draw specific hypotheses in this group. Priming cognitive flexibility may fail due for multiple reasons in older adults (e.g., failure of attentional control, attenuated priming effects, etc.).

METHODS

Participants

Sixteen older adults over the age of 60 and 24 young adults at least 18 years old were recruited for the study. One older adult participant was excluded from the study due to inability to meet the threshold for the cognitive impairment assessment. The final sample includes 15 older adults (ages 68 – 91, $M = 74.71$, $SD = 26.09$, 11 female) and 24 young adults (ages 18 – 46, $M = 23.17$, $SD = 7.12$). Young adult participants were recruited through Middle Tennessee State University research participant pool, SONA, in exchange for course credit. Older adult participants were recruited from the community and compensated \$10 per hour for their time. All participants reported having normal or corrected-to-normal vision.

All participants were screened for cognitive impairment using the Mini-Cog (Borson et al., 2000 - Appendix A). Processing speed was measured with the Digit

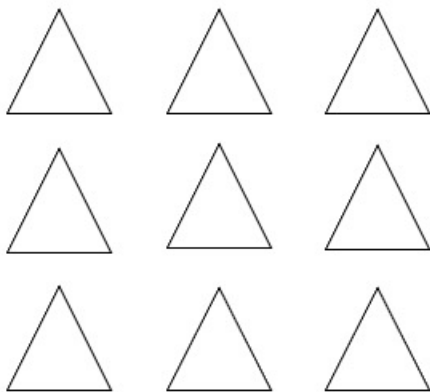
Symbol Substitution Test (Appendix B) and vocabulary was assessed with the Vocabulary IQ test (Appendix C).

Materials

Creativity Measure

Creativity was assessed using the Abbreviated Torrance Test for Adults (ATTA; Goff & Torrance, 2002). The ATTA is a shortened version of the Torrance Test of Creative thinking (TTCT; Torrance, 1966). The TTCT is the most widely used and the most referenced creativity test (Kim, 2006; Almeida et al., 2008). Further, the TTCT is one of the few well-validated creativity tests and has been shown to predict future creative achievement (Runco et al., 2010). The ATTA includes three activities and produces a score for fluency, originality, elaboration, and flexibility. Fluency refers to the number of ideas produced. Originality evaluates how novel those ideas are. Elaboration refers to the ability to provide details alongside the ideas. Flexibility reflects how different the ideas are from each other. For this study, we used Activity 3 (Figure 1). In this task, participants are presented with a set of triangles and are asked to generate objects or pictures with the given triangles.

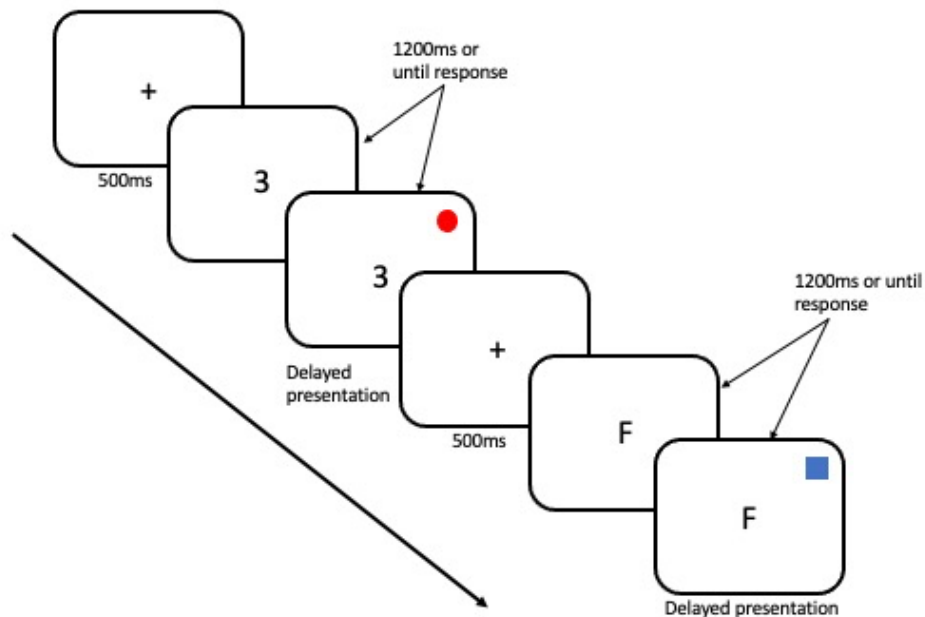
Figure 1. *Abbreviated Torrance Test for Adults*



Divided Attention Task

Participants in the experimental group were asked to attend to two tasks simultaneously (Figure 2). In the first task, participants were presented with a single digit (1-9) or a capital letter (A-Z). Letters 'I' and 'O' were omitted to avoid confusion. Participants were instructed to press the 'N' button on the keyboard using their left hand when a number is shown and to do nothing when a letter is shown. Concurrently, the spatial attention task was presented on the screen. Different shapes of varying colors were presented in one of the four corners of the screen. Participants were instructed to left click on the mouse when a red circle appears and right click when any other shape appears.

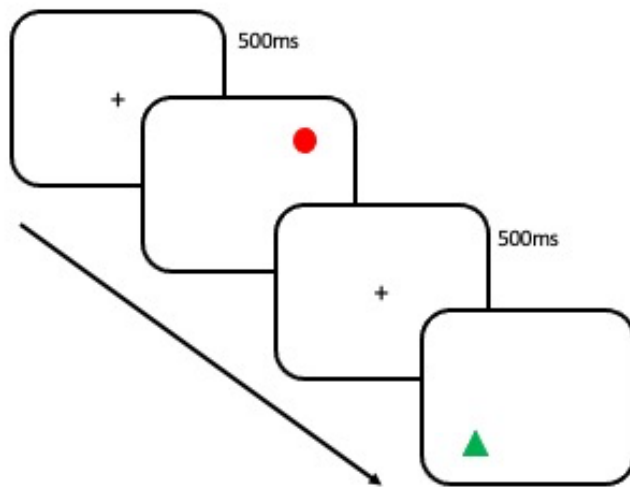
Figure 2
Diagram of the divided attention task sequence.



Participants in the control group completed the spatial attention task in isolation (Figure 3). In this task, a shape of a certain color appeared in one of the four corners. Participants were asked to press the 'F' button on the keyboard when a red circle is presented and to press the 'J' button when any other shape is presented. After the presentation of each shape, a fixation cross was shown for 500ms. There are a total of 224 trials, where half consisted of red circle trials. The task took approximately 5 minutes to complete.

Figure 3

Diagram of the spatial attention task sequence.



Procedure

Approval from the Middle Tennessee State University Institutional Review board was obtained to conduct this study (Appendix D). Once informed consent (Appendix E) was obtained from participants, they were directed to complete a brief demographic survey (Appendix F). Cognitive impairment, processing speed, and vocabulary IQ were then assessed. Next, participants were given 10 minutes to generate objects using Activity 3 of the ATTA. After the ATTA, they completed either the divided attention task or the control task depending on their group assignment. Following its completion, the participants continued with the ATTA and were given another 10 minutes to generate additional objects. Upon finishing, participants were debriefed (Appendix G) and the study concluded.

RESULTS

Descriptive statistics are shown in Table 3. Older adults and young adults did not differ in cognitive impairment. However, the young adults had faster processing speeds when compared to the older adults as measured by the Digit Symbol substitution task. On average, older adults performed better on the vocabulary IQ test. See Table 1 for *t*-test results. Jamovi (version 2.3.28) was used to perform three separate two-way ANOVAs to compare (1) total objects, (2) additional objects and (3) a proportion (additional/total) objects based on age group (older, younger) and condition (control, divided attention) (Table 2).

Table 1

t-test Results Comparing Young Adults and Older Adults

	Young Adults (<i>n</i> = 24)	Older Adults (<i>n</i> = 15)	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
	M (<i>SD</i>)	M (<i>SD</i>)			
DSST	54.21 (9.74)	42.67 (12.23)	3.26	0.002*	1.07
Mini-Cog	4.21 (0.72)	4.33 (0.72)	-0.53	0.60	-0.17
Vocab IQ	22.63 (7.67)	29.33 (9.74)	-2.40	0.02*	-0.79

Note. * indicates $p < 0.05$. DSST – Digit Symbol Substitution Task, Vocab IQ – Vocabulary IQ Test.

Table 2

ANOVA Results Comparing Creativity Based on Condition and Age

		F(1, 35)	<i>p</i>	η_p^2
Total	Condition	0.80	0.38	0.02
	Age	0.23	0.63	0.01
	Condition*Age	0.80	0.37	0.02
Additional	Condition	1.83	0.18	0.05
	Age	0.95	0.34	0.03
	Condition*Age	0.19	0.67	0.01
Proportion	Condition	0.94	0.34	0.03
	Age	1.81	0.19	0.05
	Condition*Age	0.01	0.94	0.00

Note. Condition – Divided Attention Condition.

Total Objects

The main effect for divided attention condition was not significant, $F(1, 35) = 0.80, p = 0.38, \eta_p^2 = 0.02$. The main effect for age group was not significant, $F(1, 35) = 0.23, p = 0.63, \eta_p^2 = 0.01$. There was not a significant interaction, $F(1, 35) = 0.80, p = 0.38, \eta_p^2 = 0.02$.

Additional Objects

The main effect for divided attention condition was not significant, $F(1, 35) = 1.83, p = 0.18, \eta_p^2 = 0.05$. The main effect for age group was not significant, $F(1, 35) =$

0.95, $p = 0.34$, $\eta_p^2 = 0.03$. The interaction effect was not significant, $F(1, 35) = 0.19$, $p = 0.67$, $\eta_p^2 = 0.01$.

Proportion

The main effect for divided attention condition was not significant, $F(1, 35) = 0.94$, $p = 0.34$, $\eta_p^2 = 0.03$. The main effect for age group was not significant, $F(1, 35) = 1.81$, $p = 0.19$, $\eta_p^2 = 0.05$. There was not a significant interaction, $F(1, 35) = 0.005$, $p = 0.94$, $\eta_p^2 < 0.01$.

Table 3

Descriptive Statistics for Creative Ability

		Total	Additional	Proportion
		M (SD)	M (SD)	M (SD)
Younger	Control ($n = 12$)	20.30 (9.03)	7.17 (4.95)	0.35 (0.18)
	Experimental ($n = 12$)	20.30 (9.10)	8.83 (5.64)	0.40 (0.13)
Older	Control ($n = 8$)	15.30 (10.90)	4.63 (3.29)	0.28 (0.21)
	Experimental ($n = 7$)	21.90 (17.10)	7.86 (7.73)	0.33 (0.13)

Covariates

Separate ANCOVAs were performed using DSST and vocabulary IQ scores as covariates. After controlling for processing speed, results indicated there were no significant differences regarding total objects, additional objects, or the proportion of

objects produced in the ATTA (all $p > 0.05$, $\eta_p^2 < 0.07$). Similarly, controlling for vocabulary did not yield any significant results (all $p > 0.05$, $\eta_p^2 < 0.01$).

DISCUSSION

The present study attempted to increase creative ability by priming cognitive flexibility with the use of a divided attention task. In general, those in the experimental condition generated more objects than those in the control group. Further, young adults tended to produce more objects than older adults across conditions. However, these differences were not significant. In fact, there were no significant findings with regards to the total number of objects produced, the number of objects produced after the attention task, or the proportion of additional to total objects produced.

Cognitive Flexibility Priming Effect

Participants in the experimental condition, who completed the divided attention task, performed similarly to those in the control condition. This may suggest the divided attention task did not actually prime cognitive flexibility. Cognitive flexibility has been shown to be modifiable with the manipulation of factors such as exercise, meditation, and emotional states (Müller et al., 2016; Wang et al., 2017; Mekari et al., 2020). However, there are a few reasons why the current paradigm may have failed to prime cognitive flexibility.

In a review of dual-task and task-switching research, Koch et al. (2018) discussed variants of task-switching paradigms. One variant compares single-task conditions (e.g. AAAA) to mixed task conditions (e.g. ABAB). Oftentimes to influence switching costs, tasks will be presented in a predictable or unpredictable pattern. The divided attention paradigm in the present study always follows a predictable pattern of 'ABAB'. Ritter et al. (2012) suggested that diversifying experiences that violate cognitive schemas enhance cognitive flexibility. While that study utilized virtual reality and more real-world

scenarios, it may be argued that the present study did not provide enough variation in the presentation of the tasks to impact cognitive flexibility. Future studies may try diversifying the priming task to further promote cognitive flexibility, by presenting the two tasks in an unpredictable pattern.

Practice effects should also be considered. The divided attention task takes approximately five minutes to complete. During this time, participants are able to practice and get used to the rules of the paradigm; and the rules never change. In an fMRI study, researchers found that repeated exposure to similar problems with the same solution is more likely to result in neural adaptation and cognitive inflexibility (Huang et al., 2019). Further, it has been suggested that automatic processes kick in after extensive practice within a task (Cañas et al., 2006). Once in ‘auto-pilot,’ behavior is able to be controlled by processes that require fewer resources. Therefore, a participant is less likely to adapt to, or even notice, changes to the environment. In other words, once engaged in an automatic process one is likely to persevere or become unwilling to change strategies. In the future, it may be helpful for researchers to investigate the optimal length of the priming task.

Effect of Age

The present study found no significant differences in creativity between the young adult and older adult groups. These results are consistent with previous findings suggesting that creativity does not decline with age (Lamancusa et al., 2019). Recent evidence suggests that dual-tasking performance does not decline with healthy aging (Argiris et al., 2020). However, the study also revealed that age predicted performance on tests of inhibition, task-switching, and updating. Matzel et al. (2011) found that long-term

working memory training in mice decreased risk of cognitive decline and cognitive inflexibility. In a large-scale analysis of task-switching data across the lifespan, researchers found that with practice, older adults may be able to mitigate some age-related deficits (Steyvers et al., 2019). Although the results of the current study yielded minor differences in creativity and dual-task paradigms, the evidence is sparse, contradictory, and often tangential. Further investigation is necessary to ascertain the relationship between age, cognitive flexibility, and creativity.

Limitations and Future Directions

There are several limitations of the current study that should be acknowledged. Appropriate sample selection is important for the minimization of statistical errors. The present study has a small sample size, resulting in decreased power and an increased risk of a type II error. Future studies should aim to recruit a sample size of at least 30 individuals per group. A larger sample size will not only increase power, but also increase the external validity of the study. While the young adult sample was comprised of undergraduates from Middle Tennessee State University, the older adult participants were recruited from various senior centers in Georgia and Tennessee. Older adults did not come into the lab to take part in the study, rather the researcher traveled to them. It may have been beneficial to have all participants take part in the study, in the same location to reduce risk of any unintended biases or confounding variables related to the environment.

Another limiting factor is the lack of an actual measure of cognitive flexibility. The ATTA was used to assess creative ability and with that cognitive flexibility is assessed. Similar to Guilford's original scoring guide, cognitive flexibility refers to the different categories of objects (Guilford, 1967; Goff & Torrance, 2002). For example, if

one used the triangles to draw a pizza slice and an ice cream cone, they would both fall in the category of food. If someone else used the triangles to draw a house and a hat, those objects would fall in different categories. Those who include more categories would be considered more flexible. Unfortunately, due to time constraints and other extenuating factors, only fluency – the number of objects produced – was considered. Subsequent research may want to include a more explicit measure of cognitive flexibility to determine if and how much it is being influenced.

The current study aims to make meaningful contributions to research promoting healthy aging. The implications of investigating how age and cognitive flexibility influence creativity are wide and impactful as it could promote creativity in the aging population. Additionally, creativity has been shown to be beneficial for overall health and quality of life, and may even act as a protective factor against normative age-related cognitive declines (Fisher & Specht, 1999; Cohen, 2006; Tromp & Glaveanu, 2023). This potential impact is all the more relevant given that engagement in creative activity occurs naturalistically for many as we age. By contrast, research from the past decade that examines the efficacy of cognitive training programs (e.g., Lumosity) has yielded generally poor outcomes (e.g., limited transfer of training gains to daily function and the rapid attenuation of achieved gains over time – Buitenweg et al., 2017; Sala & Gobet, 2019, though see Willis et al., 2006).

Though this study did not provide any significant findings, it highlighted pathways for future research. The effect size for the divided attention condition indicated a medium-sized effect. With additional participants added to the study, it is feasible that a significant effect would arise, indicating an age-invariant priming effect of divided

attention on creative potential. Additionally, given that priming effects are sensitive to many factors (e.g., habituation), it would also be of interest to examine flexibility priming dose-response curves on creative potential. More broadly, a comprehensive understanding of normal aging and how to manage the various challenges associated with it is increasingly important as the aging population grows. By moving outside of the lab, we can establish a better understanding of how engaging in creative activities may impact cognition and functional independence across the lifespan.

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APPENDIX

APPENDIX A

Mini-Cog

Mini-Cog®

Instructions for Administration & Scoring

ID: _____ Date: _____

Step 1: Three Word Registration

Look directly at person and say, "Please listen carefully. I am going to say three words that I want you to repeat back to me now and try to remember. The words are [select a list of words from the versions below]. Please say them for me now." If the person is unable to repeat the words after three attempts, move on to Step 2 (clock drawing).

The following and other word lists have been used in one or more clinical studies.¹⁻³ For repeated administrations, use of an alternative word list is recommended.

Version 1	Version 2	Version 3	Version 4	Version 5	Version 6
Banana	Leader	Village	River	Captain	Daughter
Sunrise	Season	Kitchen	Nation	Garden	Heaven
Chair	Table	Baby	Finger	Picture	Mountain

Step 2: Clock Drawing

Say: "Next, I want you to draw a clock for me. First, put in all of the numbers where they go." When that is completed, say: "Now, set the hands to 10 past 11."

Use preprinted circle (see next page) for this exercise. Repeat instructions as needed as this is not a memory test. Move to Step 3 if the clock is not complete within three minutes.

Step 3: Three Word Recall

Ask the person to recall the three words you stated in Step 1. Say: "What were the three words I asked you to remember?" Record the word list version number and the person's answers below.

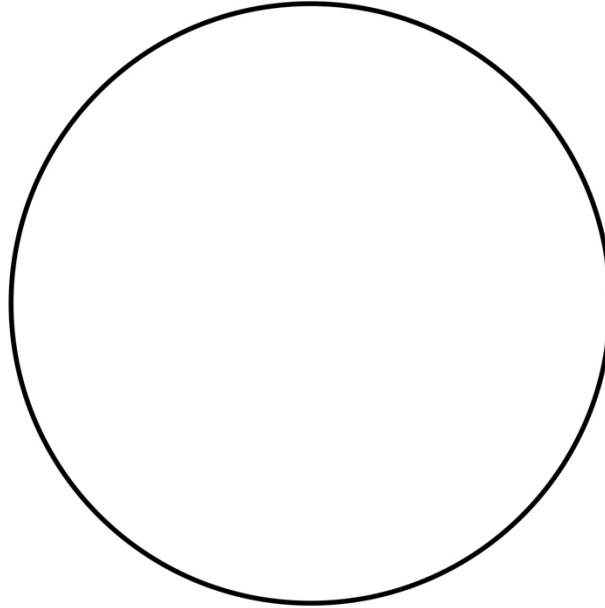
Word List Version: _____ Person's Answers: _____

Scoring

Word Recall: _____ (0-3 points)	1 point for each word spontaneously recalled without cueing.
Clock Draw: _____ (0 or 2 points)	Normal clock = 2 points. A normal clock has all numbers placed in the correct sequence and approximately correct position (e.g., 12, 3, 6 and 9 are in anchor positions) with no missing or duplicate numbers. Hands are pointing to the 11 and 2 (11:10). Hand length is not scored. Inability or refusal to draw a clock (abnormal) = 0 points.
Total Score: _____ (0-5 points)	Total score = Word Recall score + Clock Draw score. A cut point of <3 on the Mini-Cog™ has been validated for dementia screening, but many individuals with clinically meaningful cognitive impairment will score higher. When greater sensitivity is desired, a cut point of <4 is recommended as it may indicate a need for further evaluation of cognitive status.

Clock Drawing

ID: _____ Date: _____



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APPENDIX B

Digit Symbol Substitution Test

Coding

1	2	3	4	5	6	7	8	9
└)	^	—		┌	⊂	⌒	┘

Demo

Sample

6	8	3	9	5	4	1	7	2	1	4	8	2	7	6	9	3	5
8	3	1	9	2	5	6	4	3	7	2	9	8	1	4	7	6	5
9	1	2	4	7	2	5	6	9	5	8	6	4	3	1	7	8	3
1	3	9	6	3	9	7	5	1	4	2	8	7	2	8	5	6	4
7	6	4	1	3	2	8	1	7	9	2	5	3	4	8	6	5	9
8	1	9	5	1	4	2	6	9	8	7	3	5	6	4	7	2	3
3	6	8	9	1	8	4	7	5	2	9	6	7	1	5	2	3	4
6	4	1	9	5	7	3	6	8	3	2	7	5	8	4	2	9	1

APPENDIX C

Vocabulary IQ Test

A: tiny B: faded C: new D: large E: big F: don't know	A: deal B: claim C: plea D: recoup E: sale F: don't know	A: prattle B: siren C: couch D: chatter E: good F: don't know
A: shovel B: spade C: needle D: oak E: club F: don't know	A: mindful B: negligent C: neurotic D: lax E: delectable F: don't know	A: above B: slow C: over D: pierce E: what F: don't know
A: walk B: rob C: juggle D: steal E: discover F: don't know	A: quash B: evade C: enumerate D: assist E: defeat F: don't know	A: assail B: designated C: arcane D: capitulate E: specify F: don't know
A: finish B: embellish C: cap D: squeak E: talk F: don't know	A: entrapment B: partner C: fool D: companion E: mirror F: don't know	A: succeed B: drop C: squeal D: spit E: fall F: don't know
A: recall B: flex C: efface D: remember E: divest F: don't know	A: junk B: squeeze C: trash D: punch E: crack F: don't know	A: fly B: soar C: drink D: peer E: hop F: don't know
A: implore B: fancy C: recant D: beg E: answer F: don't know	A: trivial B: crude C: presidential D: flow E: minor F: don't know	A: disburse B: perplex C: muster D: convene E: feign F: don't know

A: cistern	A: related	A: silence
B: crimp	B: intrinsic	B: rage
C: bastion	C: alien	C: anger
D: leeway	D: steadfast	D: victory
E: pleat	E: pertinent	E: love
F: don't know	F: don't know	F: don't know
A: solder	A: facile	A: sector
B: beguile	B: annoying	B: mean
C: distant	C: clicker	C: light
D: reveal	D: obnoxious	D: harsh
E: seduce	E: counter	E: predator
F: don't know	F: don't know	F: don't know
A: dowager	A: capricious	A: house
B: matron	B: incipient	B: carnival
C: spank	C: galling	C: yeast
D: fiend	D: nascent	D: economy
E: sire	E: chromatic	E: domicile
F: don't know	F: don't know	F: don't know
A: worldly	A: noted	A: depression
B: solo	B: subsidiary	B: despondency
C: inverted	C: culinary	C: forswear
D: drunk	D: illustrious	D: hysteria
E: alone	E: begrudge	E: integrity
F: don't know	F: don't know	F: don't know
A: protracted	A: breach	A: memorandum
B: standard	B: harmony	B: catalogue
C: normal	C: vehement	C: bourgeois
D: florid	D: rupture	D: trigger
E: unbalanced	E: acquiesce	E: note
F: don't know	F: don't know	F: don't know
A: admissible	A: influence	A: fulminant
B: barbaric	B: power	B: doohickey
C: lackluster	C: cauterize	C: ligature
D: drab	D: bizarre	D: epistle
E: spiffy	E: regular	E: letter
F: don't know	F: don't know	F: don't know

A: titanic
B: equestrian
C: niggardly
D: promiscuous
E: gargantuan
F: don't know

A: omen
B: opulence
C: harbinger
D: mystic
E: demand
F: don't know

A: fixed
B: rotund
C: stagnant
D: permanent
E: shifty
F: don't know

A: stanchion
B: strumpet
C: pole
D: pale
E: forestall
F: don't know

A: hightail
B: report
C: abscond
D: perturb
E: surmise
F: don't know

A: yearn
B: reject
C: hanker
D: despair
E: indolence
F: don't know

A: fugacious
B: vapid
C: fractious
D: querulous
E: extemporaneous
F: don't know

A: introduce
B: terminate
C: shatter
D: bifurcate
E: fork
F: don't know

A: cardinal
B: pilot
C: full
D: trial
E: inkling
F: don't know

APPENDIX D

Institutional Review Board Approval

Date: 2-28-2023

IRB #: IRB-FY2023-17

Title: Creativity, Flexibility, and Aging

Creation Date: 1-15-2023

End Date:

Status: **Approved**

Principal Investigator: Denise Ealy

Review Board: MTSU Institutional Review Board

Sponsor:

Study History

Submission Type	Initial	Review Type	Expedited	Decision	Approved
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APPENDIX E

Informed Consent

Information and Disclosure Section

The following information is provided to inform you about the research project in which you have been invited to participate. Please read this disclosure and feel free to ask any questions. The investigators must answer all of your questions.

For additional information on your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance (Tel 615-494-8918 or send your emails to irb_information@mtsu.edu. (URL: <http://www.mtsu.edu/irb>).

Please read the following and respond to the consent questions in the bottom if you wish to enroll in this study.

Purpose: The purpose of this study is to research factors affecting creativity. We are specifically interested in how cognitive flexibility may impact an individual's creative ability. We are also interested in differences across age groups (young adults vs. older adults).

Description: The study has several parts: (1) A task that asks you to generate picture or objects (approx. 10 min), (2) a task that asks you to make quick decisions (approx. 5 min), (3) another task that asks you to generate pictures or objects (approx. 15 min), and (4) a series of questionnaires (approx. 10 min). To complete the first three tasks, the experimenter begin a program called SuperLab. Once you completed the first three parts via SuperLab, a prompt will appear that directs you get the experimenter so that you may return to the Qualtrics website for the last part and for debriefing information.

You will NOT be audio recorded or videotaped in this study.

Duration: The whole activity should take about 35-45 minutes (including breaks)

IRB Approval Details

- Protocol Title: Creativity, Flexibility, and Aging
- Primary Investigator: Denise Ealy
- PI Department & College: Department of Psychology, College of Behavioral and Health Sciences
- Protocol ID:

Here are your rights as participants:

- Your participation in this research is voluntary.

- You may skip any item that you don't want to answer, and you may stop the experiment at any time (but see the note below)
- Some items may require a response to accurately present the survey.
-

Risks & Discomforts: There are no known risks or discomforts associated with the protocol.

Benefits: There are no direct benefits. Data from the study will contribute to the academic understanding of creativity.

Identifiable Information: You will NOT be asked to provide identifiable personal information.

Compensation: You will be provided course credit either directly or via the SONA system, depending upon your method of study enrollment.

Compensation Requirements: The qualifications to participate in this research are that that you must be of 18 years of age and have access to an internet-connected Windows personal computer (either a laptop, or desktop). If you do not meet these qualifications, you will not be included in the research and you will not be compensated.

- After you complete this consent form you will answer screening questions. If you fail to qualify for the research based on these questions, the research will end and you will not be compensated.
- Please do not participate in this research more than once. Multiple attempts to participate will not be compensated.

Confidentiality. All efforts, within reason, will be made to keep your personal information private but total privacy cannot be promised. Your information may be shared with MTSU or the government, such as the Middle Tennessee State University Institutional Review Board, Federal Government Office for Human Research Protections, if you or someone else is in danger or if we are required to do so by law.

Contact Information. If you should have any questions about this research study or possibly injury, please feel free to contact:

- Denise Ealy by email @ dme3f@mtmail.mtsu.edu
- Dr. James R. Houston by telephone at 615.898.5641 or by email at james.houston@mtsu.edu.

You are not required to do anything further if you decide not to enroll in this study. Just quit contact your experimenter. Please complete the response section below if you wish to learn more or you wish to part take in this study.

Consent

I have read this informed consent document pertaining to the above identified research.

- Yes
- No

The research procedures to be conducted are clear to me.

- Yes
- No

I confirm that I am 18 years or older.

- Yes
- No

I am aware of the potential risks of the study

- Yes
- No

By clicking below, I affirm that I freely and voluntarily choose to participate in this study. I understand I can withdraw from this study at any time without facing any consequences.

- Yes, I consent
- No, I do not consent

APPENDIX F

Socio-demographic Survey

What is your gender?

- Male
- Female
- Prefer not to say
- Other (please specify): _____

What is your nationality? _____

What is your first language? _____

How old are you (in years)? _____

What is your current student status?

- Undergraduate, year 1
- Undergraduate, year 2
- Undergraduate, year 3
- Undergraduate, year 4
- I am not a student
- Other (please specify): _____

APPENDIX G

Debriefing form

Debriefing Study Information.

The purpose of this study is to research factors affecting creativity. We are specifically interested in how cognitive flexibility may impact an individual's creative ability. We are also interested in differences across age groups (young adults vs. older adults).

With this study we aim to prime cognitive flexibility to facilitate creative ability.

To test this assumption, we guided participants to complete a creativity measure in which the participants were presented with a number of triangles. The participants were asked to use the triangles to make objects or pictures.

Next, we randomly assigned study participants to two different groups. Approximately half of the participants were instructed to complete a divided attention task in which participants were asked to perform two tasks simultaneously. In the first task participants were asked to press a button when a number was presented and to not respond when a letter was shown. Concurrently, participants were asked to take part in a spatial attention task which asked them to click on the red circle when it appeared. The other half of the participants asked to complete the spatial isolation task in isolation. Further, roughly half of the participants are older adults, while the other half consists of younger adults.

Lastly, we instructed participants to return to the first task and attempt to generate more objects or pictures. We will analyze if there is a difference in the scores on the creativity measure for participants who completed the divided attention task compared to those who completed a single task.

We will also analyze if there is a difference in creativity scores for younger adult participants when compared to the older adults. We predict that those in the divided attention condition will have increased cognitive flexibility and therefore, higher creativity scores. In other words, those who performed two tasks simultaneously, are likely to have an easier time switching strategies or changing perspectives thus, allowing them to produce more pictures. We also predict successful priming in the younger adult group. However, we have no particular expectations for the older adult group.

Thank you again for participating. Your participation is of great help for us!

For any further information, kindly get in touch with
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