Creativity and Cognitive Abilities: How Are They Related?

By

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ABSTRACT

Research has explored creativity, intelligence, and executive function; however, the potential relationship among all three constructs is limited by inconsistencies in measurement and methodological strategies. Fifty-three college students at Middle Tennessee State University completed an abbreviated intelligence test, a creativity task, and three measures of executive function. Linear regression and PROCESS moderation models were utilized to analyze participant data. Results demonstrated that creativity was significantly positively correlated with abbreviated intelligence, specifically fluid intelligence, and two measures of executive function, updating and inhibition. Interactions between intelligence and shifting, as well as crystallized intelligence and updating, significantly predicted creativity. The strength of these associations, however, differed based on the variation of scores on measures of executive function and intelligence. Thus, different patterns of scores on measures of executive function and intelligence may modulate the relationship between all three constructs when analyzed simultaneously.

Keywords: creativity, executive function, intelligence.

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CHAPTER I

LITERATURE REVIEW

Creativity has been defined and conceptualized in various ways across disciplines and is often focused on the production of novel and useful ideas or products (Benedek et al., 2014; Taylor & Zaghi, 2021). Creative thinking has been explored as divergent thinking, the generation of multiple and alternative responses from given information (Pan & Yu, 2016). Characteristics of creative responding include fluency (the number of ideas generated), flexibility (the number of different categories generated), and originality (response originality). These characteristics can then be further categorized as qualitative (originality) or quantitative (fluency and flexibility) in response to verbal or figural tasks (Benedek et al., 2012; Pan & Yu, 2016). Creativity has been linked to both intelligence and executive functioning, two constructs that also have been defined and measured in various ways.

Sternberg (1997) defined intelligence as the mental abilities utilized to adapt and shape one's environment (as cited by Taylor & Zaghi, 2021). One aspect of intelligence that has been implicated frequently in the relationship with both creativity and executive function is fluid intelligence. Fluid intelligence can be conceptualized as a higher mental process relating to the ability to solve novel problems using reasoning (van Aken et al., 2016). While not often investigated within this context, crystallized intelligence is the accumulation of knowledge through education and experience (Schnieder & McGrew, 2012; as cited by Taylor & Zaghi, 2021). Executive function typically refers to cognitive processes that control thought and action (Friedman et al., 2006). Relative to creativity and intelligence, three aspects of executive function that have been assessed are updating, shifting (switching), and inhibition (Benedek et al., 2014; Friedman et al., 2006; Zabelina et al., 2019). Updating refers to a function of working memory in that more recent and relevant incoming information is monitored and revised to replace outdated information (Jonides & Smith, 1997; as cited by Benedek et al., 2014). Thus, attentional control is required for the maintenance of relevant information (Engle et al., 1999; Miyake et al., 2000; as cited by Friedman et al., 2006). Shifting is the process of alternating one's attention and actions between various tasks, or conditions, as appropriate (Monsell, 1996; as cited by Benedek et al., 2014). Inhibition refers to the ability to suppress dominant and irrelevant responses. Evidence has demonstrated that the nature of inhibition's relationship to creativity has been diverse, in that both positive and negative associations with creativity have been achieved. Prior theories of creative function have suggested that a lack of inhibition aids in the fluency of idea generation, yet studies have presented conflicting evidence that either support or dismantle this claim. The function of inhibition and its relevance to the production of original ideas has yet to be determined (Benedek et al., 2012; Benedek et al., 2014). Clearly defining and measuring these aspects of intelligence and executive function has been a challenge in the research associating these constructs with creativity. This literature review provides a summary of the empirical work assessing the associations between creativity, intelligence, and executive function. A current study is proposed to further explore the relationships among the three constructs and to address assessment method inconsistencies.

Creativity and Intelligence

Multiple aspects of intelligence and creativity and their relationship with each other have been explored. Overall intelligence as well as specific types of intelligence (e.g., fluid, crystallized) have been investigated in relation to overall creativity as well as specific aspects of creativity (e.g., divergent thinking, verbal creativity, figural creativity, etc.). These studies demonstrate consistent connections between intelligence, creativity, and their neurological bases.

Creativity is determined by distinct aspects of an individual's response pattern including qualitative and quantitative aspects of responses. Stemming from this dichotomous categorization, three indicators of divergent thinking have been frequently identified including ideational fluency, flexibility, and originality. Specifically, these indicators display information regarding how many ideas were generated, how many different categories were produced, and how original or creative the ideas were (Benedek et al., 2012; Pan & Yu, 2016). In their studies with college students, ideational originality, a qualitative aspect of divergent thinking, displayed a stronger correlation with intelligence when compared to more quantitative aspects (fluency and flexibility) of divergent thinking (Benedek et al., 2012; Pan & Yu, 2016). Similarly, in their first experiment, Nusbaum and Silvia (2011) utilized a method of scoring that identified clustering, the number of responses within a single category, and switching, the number of different categories, within the given creativity tasks that college students had completed. Higher scores on fluid intelligence tasks were associated with more category changes during the given divergent thinking tasks. However, the number of responses per category did not significantly differ. Within their studies with college engineering students, Taylor and Zaghi (2021, 2022) identified two characteristics of divergent thinking, verbal and figural, and their relationship to verbal (crystallized) and nonverbal (fluid) intelligence. Originality ratio scores were computed by removing the confounding effect of fluency from divergent thinking originality response scores along with utilizing traditional scoring methods. When using traditional scoring methods, fluid intelligence moderated the interaction between both verbal and figural divergent thinking tasks and high levels of fluid intelligence were associated with high scores on divergent thinking tasks (Taylor & Zaghi, 2021). Alternatively, Taylor and Zaghi (2022) found that both verbal and figural divergent thinking scores were significantly associated with verbal intelligence, not nonverbal intelligence. Although ideational fluency, originality, and flexibility have been detailed for responses on verbal divergent tasks, a dimension of elaboration (response detail) was included when rating figural divergent thinking responses. Verbal intelligence was related to both verbal and figural divergent thinking while nonverbal intelligence was only related to figural divergent thinking.

Frith et al. (2021a) mapped the functional connectivity of intelligence and creativity within the brain with college students. Subtraction for the functional magnetic resonance imaging (fMRI) was not reported. While engaged in a brief Alternate Uses Task (AUT; a divergent thinking task), fMRI was conducted. Separately, participants were instructed to generate creative uses for a common object, as part of the AUT, and to think of standard characteristics of common objects while undergoing fMRI, as part of the Object Characteristics Task (OCT). Additionally, participants completed these same tasks, with novel common objects, without undergoing fMRI. They found that intelligence and creativity, specifically divergent thinking, overlapped prominently in regions of the brain that encompass connectivity patterns associated with executive control, salience/ventral attention, and visual networks. The executive control network is located within the frontoparietal region of the brain, and the default network is located within the parietal lobe and along the midline. The prefrontal cortex was the region of the brain with the most consistent overlap with respect to all aspects of lower-order intelligence when compared with divergent thinking. Regarding general intelligence, about half of its functional connectivity patterns overlapped with those associated with divergent thinking. More response originality was observed within participants that displayed stronger connections within the left executive control network, along with other attentional networks, based on patterns of functional connectivity during a divergent thinking task.

Regarding creativity, divergent thinking has been found to have the strongest relation to intelligence. Both lower-order (specific) and higher-order (general) facets of intelligence have been investigated including crystallized intelligence (Gc), fluid intelligence (Gf), and general intelligence (g). All facets of intelligence have been associated with divergent thinking, but fluid intelligence has indicated a stronger correlation with divergent thinking (Frith et al., 2021b; Nusbaum & Silvia, 2011; Taylor & Zaghi, 2021). These findings, however, may be confounded by sex differences, with more than half of the samples consisting of females (e.g., Benedek et al., 2012; Frith et al., 2021a, Frith et al., 2021b, Nusbaum & Silvia, 2011, Pan & Yu, 2016), and differences regarding the measurement of divergent thinking (Taylor & Zaghi, 2021). Patterns between intelligence and creativity differ depending on the scoring, or rating, method utilized.

The strength of the relationship between intelligence and divergent thinking could be distinguished based on higher intelligence scores and the type of divergent thinking task, either verbal or figural. Amongst differences in gender makeup of the identified samples, a study that consisted of mostly males observed a departure from fluid intelligence being significantly related to divergent thinking. In this case, verbal intelligence was strongly related to both verbal and figural characteristics of divergent thinking (Taylor & Zaghi, 2022).

Creativity and Executive Function

Executive function and its relationship to creativity, specifically divergent thinking, has been explored. When assessing aspects of creativity, both verbal and figural divergent thinking, overall executive function and components of executive function have been implicated, including updating, shifting, and inhibition.

As these three components of executive function have been investigated, there are mixed results as to which aspects are more strongly related to divergent thinking. Some studies have investigated all three components of executive function (Benedek et al., 2014; Zabelina et al., 2019) or two components, inhibition and working memory (Camarda et al., 2018). Although, some studies have only investigated inhibition (Benedek et al., 2012) and shifting (Pan & Yu, 2016) alone. Frith et al. (2021b) investigated executive attention and its relationship to divergent thinking in their study of college students. Executive attention encompassed assessments related to working memory and response inhibition. They found that executive attention and divergent thinking were positively associated. As specified aspects of executive function were found to significantly predict divergent thinking, only some characteristics of divergent thinking (fluency, flexibility, and originality) were predicted. Benedek et al. (2014) observed that updating and inhibition significantly predicted response originality on a divergent thinking task, but not shifting. Updating, as compared to inhibition, displayed a stronger association to divergent thinking, with only response originality evaluated. With all three characteristics of divergent thinking being evaluated, quantitative aspects of divergent thinking were significantly positively correlated with various aspects of executive function within their studies comprised of college students (Benedek et al., 2012; Camarda et al., 2018; Pan & Yu, 2016). Specifically, Camarda et al. (2018) conducted an investigation in which participants were placed into one of three conditions: a dual-task condition, control dual-task condition, or a single-task condition. The single-task condition only consisted of the creativity task in which creative responses were to be provided regarding how to ensure a hen’s egg does not break when dropped from a specified height. Participants within the dual-task conditions completed an inhibition task, the Color Word Stroop task, on a computer concurrently with the creative task. The control dual-task condition completed a congruent condition of the inhibition task while the inhibition dual-task condition completed an incongruent condition of the task. As these tasks were to occur simultaneously, creative responses were verbalized into a microphone as they keyed in responses on a keyboard for the inhibition task. They found that participants placed within the inhibition dual-task condition produced less solutions than participants within the dual-task control group and the single-task group. Additionally, fewer expansive (original) responses were observed from participants in the inhibition dual-task group than the single-task group. A second experiment was conducted with the same procedures but with either a low-demanding or high-demanding working memory task (dot memory). There were no significant differences observed regarding the fluidity (fluency) or expansivity of responses for participants who engaged in the high-demand dual-task condition than the single-task condition. Similarly, Pan and Yu (2016) observed a positive relationship between fluency and flexibility, not response originality, when compared with shifting; although, this was the only executive function explored. On the other hand, in their study of adults from different professional domains (artistic or information technology), Zabelina et al. (2019) found that updating was the only component of executive function that predicted response fluency, not response originality.

The relationship between creativity, specifically divergent thinking, and executive functioning has been explored. Particular aspects of executive function have been identified as significant within this relationship to divergent thinking including updating, shifting, and inhibition. All three aspects of executive function are independently associated with divergent thinking and specified characteristics of divergent thinking (originality, fluency, and flexibility). The inconsistency amongst studies investigating this relationship contributes to the inability to pinpoint which executive function displays the strongest relationship with divergent thinking. There appears to be no consistency in how executive function is measured in that only a few studies have included overall executive function (Zabelina et al., 2019) or all identified aspects of executive function (Benedek et al., 2014; Zabelina et al., 2019) as factors when examining the relationship to divergent thinking. Also, not all indicators of divergent thinking have been explored with all, or some, aspects of executive function. Some studies have only included response originality (Benedek et al., 2014; Frith et al., 2021b), fluency and originality (Zabelina et al., 2019); although, some have explored all three indicators (Benedek et al., 2012; Camarda et al., 2018; Pan & Yu, 2016). When assessing executive function, there may be discrepancies in results based on how specific aspects are measured. The executive function assessments chosen either subsume all functions or the individual aspects are not comprehensive of how the specified function is fully conceptualized. Specifically, Benedek et al. (2012) noted that their utilization of the random motor generation task may have interfered with their results as not all aspects of inhibition were captured using this task. Depending on the assessment method or how an aspect of executive function is conceptualized, the relationship between executive function and divergent thinking may be affected.

Creativity, Intelligence, and Executive Function

Differences in the relationship between creativity, intelligence and executive function appeared based on which scoring method was utilized. When using traditional scoring methods, lower executive functioning ability was associated with lower divergent thinking task scores in participants with low levels of fluid intelligence while higher divergent thinking task scores were associated with higher levels of fluid intelligence. Taylor and Zaghi (2021) found that these were unrelated when fluid intelligence scores fell in the mid-range. When using originality ratio scores, the relationship between executive function and figural originality ratios was not moderated by fluid intelligence. Overall, lower verbal originality ratio scores were associated with low scores of intelligence when executive function abilities were also low while they were unrelated with intelligence scores that fell within a mid-to-high range. Participants with higher intelligence scores also had higher verbal originality ratio scores, but not higher figural originality ratio scores (Taylor & Zaghi, 2021).

Apart from scoring methods, how a component of this relationship was measured displayed an influence on creative response outcomes. In Nusbaum and Silvia's (2011) first experiment, creative responses from the participants were explained as a function of executive function ability (clustering and switching) but did not measure aspects of executive function explicitly. On the other hand, their second experiment measured executive function during a creative task as facilitated by strategizing creative responses. Expanding upon their first experiment in which fluid intelligence and creativity were significantly related, experiment two required a group of participants to utilize a disassembling strategy during an unusual uses task. Participants were either to complete the task with no help while a second group, the strategy group, was given additional instructions to imagine dissembling an object and using or recombining its parts to produce more expansive creative responses relating to the object's uses. They found that higher scores on the divergent thinking task were associated with high fluid intelligence scores and participants in the control condition (no strategy). Additionally, high fluid intelligence scores were more strongly predictive of creativity scores among participants within the strategy condition. Benedek et al. (2014) analyzed three aspects of executive function including updating, shifting, and inhibition and their relation to creativity and fluid intelligence. They found that updating was predictive of creativity and fluid intelligence, with fluid intelligence being more strongly predicted. Inhibition was predictive of creativity, but not fluid intelligence, while shifting was not significantly predictive of either. The addition of the three executive functions into the full model reduced the correlation between intelligence and creativity, yet it remained significant. This reduction was attributed to the influence of updating as it was the only executive function to significantly predict intelligence and creativity.

Pan and Yu (2016) found that intelligence mediated the relationship between the executive ability of shifting and divergent thinking. They found a low correlation between cognitive shifting and intelligence, yet cognitive shifting was predictive of creativity. This relationship reflects that certain aspects of divergent thinking modulate this relationship in that both cognitive shifting and intelligence are related to quantitative or qualitative aspects, respectively, of divergent thinking. On the other hand, with just the aspect of inhibition being investigated along with divergent thinking and intelligence, a similar pattern was observed (Benedek et al., 2012). Overall, the way these aspects are defined and measured creates distinct differences in creative response outcomes.

Summary and Purpose of the Current Study

Among creativity, executive function, and intelligence, significant relationships have been identified. Researchers have reported that creativity and intelligence are significantly correlated, as well as creativity and executive function; however, few studies have evaluated the potential relationships across all three constructs. This literature is limited, however, by measurement and methodological inconsistencies.

Studies focused on creativity and intelligence have found both fluid and crystallized intelligence to be related to creativity, with fluid intelligence being more emphasized in this relationship. The findings vary, however, depending on how creativity is measured. Qualitative aspects of divergent thinking were found to correlate more strongly with intelligence when compared to quantitative aspects (Benedek et al., 2012; Pan & Yu, 2016), yet category flexibility (quantitative) was strongly related to higher fluid intelligence scores (Nusbaum & Silvia, 2011). Taylor and Zaghi (2021, 2022) differentiated between verbal and figural (nonverbal) characteristics of divergent thinking. Verbal and figural divergent thinking were significantly associated with verbal intelligence; however, only figural divergent thinking was associated with fluid intelligence. To further evaluate the relationship between creativity and intelligence, Frith et al. (2021a) utilized fMRI to accentuate the functional connectivity patterns within the brain regarding the regions encompassing these two constructs. Significant overlap was found amongst creativity and intelligence and regions of the brain associated with the executive control network, salience/ventral attention, and visual networks. Overall, creativity and intelligence have been significantly related.

Creativity and executive function also have been significantly positively associated by various researchers (Benedek et al., 2012; Camarda et al., 2018; Pan & Yu, 2016). Both verbal and figural aspects of divergent thinking have been explored relative to three executive function aspects including updating, shifting, and inhibition. Updating, shifting, and inhibition have been related to divergent thinking (verbal and figural) and creative response characteristics (quantitative and qualitative). Positive correlations have been found between quantitative aspects of divergent thinking and executive function (Benedek et al., 2012; Camarda et al., 2018; Pan & Yu, 2016), yet not all aspects of each construct have been measured simultaneously. Clearly methodological factors are confounding our understanding of the relationship between creativity and executive function.

Very few researchers have assessed the potential relationships among creativity, intelligence, and executive function, and those who have report conflicting results. Traditional scoring methods of creativity tasks yielded results indicating that low intelligence scores moderated the relationship between executive function and divergent thinking while the originality ratio method did not yield results indicating a moderation amongst such constructs (Taylor & Zaghi, 2021). Differences in how executive function is measured affects results as well, with some studies conceptualizing executive function as an outcome of creativity (Nusbaum & Silvia, 2011) while others conceptualize it as an independent construct that was measured (Benedek et al., 2014; Taylor & Zaghi, 2021). Benedek et al. (2014) emphasized that the updating aspect of executive function indicated stronger predictability of creativity and fluid intelligence rather than shifting and inhibition. Specifically, inhibition only predicted creativity while shifting was not predictive of either construct. Shifting (Pan & Yu, 2016) and inhibition (Benedek et al., 2012) independently indicated similar patterns in that they are related to both intelligence and divergent thinking.

Although a few patterns of relationships have been consistently reported among these three variables, inconsistent findings are more common. One primary concern is the tendency for researchers to use different scoring methods of creativity (i.e., traditional, originality ratio, and originality scoring methods) or one aspect of executive function (e.g., updating, shifting, inhibition). Notable imbalances of gender also have been observed across these studies, with more than half of the samples comprised of more females than males (Benedek et al., 2012; Frith et al., 2021a; Frith et al., 2021b; Nusbaum & Silvia, 2011; Pan & Yu, 2016). Ultimately, these methodological differences have produced inconsistencies in outcomes.

Therefore, the purpose of the current study was to investigate the relationships among all three variables (i.e., creativity, intelligence, and executive function) within the same sample using psychometrically sound measures. Specifically, we assessed 1 aspect of creativity (total creativity), and the potential association with 3 aspects of executive function (updating, shifting, and inhibition), and 3 aspects of intelligence (abbreviated, fluid, and crystallized), all of which have been identified as independently related to creativity in previous studies. We predicted that each of the primary variables–creativity, intelligence, and executive function–would be positively correlated with one another, and that intelligence would moderate the relationship between creativity and executive function.

CHAPTER II

METHOD

Participants

Students were recruited from the Psychology Department Research Pool and from additional courses from Middle Tennessee State University (MTSU). Eligible students were between 18 to 30 years old and currently enrolled at MTSU. All genders and all ethnicities were eligible to participate. This sample was comprised of 53 participants, ranging from 18 to 26 years old (M = 19.53, SD = 2.35). Of these 53 participants, more female students participated than male students (64.2% female, 30.2% male). In addition, participants were primarily freshmen and Caucasian. Refer to table 1 for a summary of the demographic information.

Measures

Demographics

The participants completed a demographic form reporting their age, gender, year in school, ethnicity and major (see Appendix A). These data were used to describe the sample and for use of normative scoring of the dependent measures. Participants also reported any history of traumatic brain injuries (TBIs) such as concussion, head injury with loss of consciousness, and stroke, and any current medications.

Table 1

Demographic Data

	N	%
Gender		
Male	16	30.2
Female	34	64.2
Non-Binary	2	3.8
Transgender	1	1.9
Ethnicity		
Caucasian/White	25	47.2
African American/Black	10	18.9
Asian/Pacific Islander	5	9.4
Hispanic/Latino	6	11.3
Other	7	13.2
Year		
Freshman	33	62.3
Sophomore	7	13.2
Junior	6	11.3
Senior	7	13.2

Note. The ‘Other’ ethnicity category was included for participants to select if they identified as an unlisted ethnicity or if they identified as more than one.

Creativity

Abbreviated Torrance Test for Adults (ATTA). The ATTA (Goff & Torrance, 2002) was administered to assess creative thinking abilities, specifically divergent thinking. The ATTA consists of three activities, one verbal and two drawing items, with a time-limit of three minutes for each activity. The ATTA is scored based on norm-referenced measures of creative thinking including fluency, originality, elaboration, and flexibility. Raw scores for each indicator are then converted into a scaled score. A Total Scaled Score can be obtained by summing these scaled scores (normalized standard scores; $M = 10$, $SD = 3$) from the individual measures of creative thinking. Psychometrically, the ATTA shows test-retest reliability of .84 for total abilities. Interrater reliability coefficients ranged from .88 to .97 for the four creativity measures, and internal consistency was .72. The Total Creative Ability score yielded a predictive validity coefficient of .59 (Althuizen et al., 2010). Regarding discriminant validity, Althuizen et al. (2010) compared ratings of creative ability given by supervisors against the performance of new recruits and long-term employees on the ATTA. These ratings correlated significantly with ATTA scores for long-term employees but insignificantly for new recruits. For this study, two researchers independently scored 20% of the ATTAs. The raters then discussed any discrepancies in scoring, which were found on only 3 protocols; scores varied by 2 points or fewer. For these three protocols, scores were corrected after discussion. The total scaled score was used as the dependent measure to indicate creative functioning in this study.

Intellectual Functioning

Abbreviated Stanford Binet – 5 (ABIQ-5). The ABIQ-5 from the Stanford Binet Test of Intelligence – 5th edition (SB-5; Roid, 2003) was administered to assess fluid and crystallized intelligence. The ABIQ consists of two subtests, Nonverbal Fluid Reasoning and Verbal Knowledge. Both subtests are administered using the standardized format, with raw scores translated into scaled scores which are normalized standard scores (M = 10, SD = 3). An overall ABIQ is calculated from these two subtests, which is an estimated overall intelligence (IQ) score (M = 100, SD = 15). Psychometrically, the ABIQ shows test-retest reliabilities of .80 (uncorrected) and .84 to .88 (corrected). The ABIQ shows criterion validities of .81 with the Weschler Adult Intelligence Scale-III Full Scale Intelligence Quotient (WAIS-III FSIQ), .69 with the Weschler Intelligence Scale for Children-III (WISC-III) FSIQ, and a range of .81 to .87 with the SB-5 FSIQ (Roid, 2003). In the current study, the ABIQ, Nonverbal Abbreviated IQ (NVAIQ), and the Verbal Abbreviated IQ (VAIQ) scores were used to indicate intellectual functioning.

Executive Function

Stroop Color and Word Test (SCWT) Golden Version. The SCWT Golden Version (Golden & Freshwater, 2002) was administered to assess the inhibition aspect of executive function. The SCWT consists of three trials: word reading, color naming, and color-word. Participants are given 45 seconds to name the stimuli as fast as they can with minimal errors. Four scores can be obtained from the SCWT: word score (W), color score (C), color-word score (CW), and an interference score. Raw scores are calculated for each score, indicating how many items were read during the time limit for each of the three trials. Adjusted scores are obtained by utilizing predicted information for normal performance based on age and education, thus predicted scores for W, C, and CW can be determined. These adjusted scores are subtracted from the raw scores to create a residual score, which are translated to T scores (M = 50, SD = 10). Psychometrically, SCWT has shown test-retest reliabilities of .83 for the word score, .74 for the color score, and .67 for the color-word score (Golden, 1975; as cited by Strauss et al., 2006). Correlations between test trials were moderate to high. Among the three trials of the SCWT, the interference score from the color-word trial has been moderately correlated with measures of attention including omission errors on continuous performance tasks, the Paced Auditory Serial Addition Test (PASAT), stopping probability and time on the stop-signal task, and between trails A and B on the Trail Making Test (TMT) (Strauss et al., 2006). In the current study, the CW score was used to indicate the inhibition aspect of executive functioning.

Trail Making Test (TMT). The TMT Part A and B were administered to assess the shifting (mental flexibility), also referred to as switching, aspect of executive functioning. The TMT consists of two parts, A and B, in which participants are to connect encircled numbers sequentially (Part A) and encircled numbers and letters in alternating order (Part B). Completion time is recorded and utilized to calculate z scores and percentiles. The TMT has shown test-retest reliabilities of .79 for Part A and .89 for Part B. Both Part A and Part B correlated moderately with each other, with a correlation coefficient of .31. TMT Part B was moderately correlated with the Symbol Digit Modality Test, a measure of speeded processing. Additionally, TMT B was more strongly correlated with the Wisconsin Card Sorting Task (WCST) regarding cognitive flexibility (the percentage of perseverative errors) (Strauss et al., 2006). Tombaugh's normative data was utilized for the purpose of this study (Tombaugh, 2004). In the current study, z scores were used to indicate the shifting, or switching, aspect of executive functioning.

Auditory Consonant Trigrams (ACT) – Adult Version. The ACT, also referred to as the Brown-Peterson Task, was administered to assess the executive function aspect of updating or working memory. The ACT consists of several trials in which consonant trigrams are read to the participant and they are asked to be recalled after a specified delay interval, either 9, 18, or 36 seconds. Simultaneously, participants are asked to count backwards by threes from different two- or three-digit numbers. The number of correct letters recalled are summed for each trial for the different interval periods. Raw scores are translated into z-scores and percentiles based on the participant's age. Psychometrically, a high internal consistency of .85 was calculated. No correlation coefficients were reported for test-retest reliability, but significantly higher scores were obtained on the second visit (1 week) compared to the first visit; however, small effects were found. The ACT shows modest concurrent validity with other measures of executive function including the WCST, SCWT, and the FAS, as well as to Digit Span Backward with a range of .54 to .57 (Strauss et al., 2006). In the current study, the overall z-score from the ACT was used to indicate the updating aspect of executive functioning by averaging the three scores obtained from the delay trials.

Procedures

This study was conducted in person. Approval from the Institutional Review Board (IRB) was obtained before proceeding (see Appendix B). During the testing session, participants provided written consent first (see Appendix C). Then, they completed a demographics form, then the ABIQ-5, the ATTA, the TMT, the SCWT, and the ACT. The order of these tools was randomized to control for potential order effects.

Hypotheses

The following hypotheses were tested.

1. Consistent with previous research, it was predicted that measures of creativity, intelligence, and executive function would all be significantly positively correlated with one another. The ABIQ, NVAIQ, VAIQ as measures of intelligence, TMT B z-score for completion, ACT z-score for average total correct recall, and SCWT color-word t-score as measures of executive function, and ATTA total scaled score as a measure creativity were used to test this hypothesis.
2. It was further predicted that intelligence would moderate the relationship between executive functioning and creativity. Specifically, it was predicted that those with average or above average intelligence scores would demonstrate a stronger positive relationship between executive function and creativity than those of low average or below average intelligence. For the purpose of this study, ABIQ was categorized as a binary variable with scores below 100 identified as ‘Low IQ’ and scores greater than or equal to 100 identified as ‘High IQ’.

CHAPTER III

RESULTS

Pearson product moment correlations were calculated to test if measures of intelligence, executive function, and creativity are significantly positively correlated. See Table 2 for descriptive statistics and Pearson correlations. As predicted, creativity was significantly positively correlated with intelligence (r^2 = .12, *p* =.01), fluid intelligence (r^2= .14, *p* = .006), updating (r^2= .08, *p* = .04), and inhibition (r^2= .14, *p* = .007). Crystallized intelligence was not significantly correlated with measures of creativity or executive function. Additionally, shifting was not significantly correlated with measures of creativity or intelligence.

Table 2

Descriptive Statistics and Pearson Correlations for the Entire Sample (N = 53)

				Pearson Correlations					
	N	M	SD	2	3	4	5	6	7
1. ABIQ	53	98.5	9.4	.87*	.69*	.19	.21	.09	.35*
2. NVAIQ	53	9.2	2.3		.25	.08	.13	-.05	.38*
3. VAIQ	53	10.3	1.6			.26	.23	.25	.12
4. TMT B	53	-.7	1.41				.30*	.48*	.23
5. ACT	53	-.7	1.0					.47*	.28*
6. CW	51	52.7	9.1						.38*
7. ATTA	51	61.8	6.3						

*$p < .05$

Note. ABIQ = Abbreviated Intelligence Quotient. NVAIQ = Nonverbal Abbreviated Intelligence Quotient. VAIQ = Verbal Intelligence Quotient. TMT B = Trail Making Test B. ACT = Auditory Consonant Trigrams. CW = Color Word. ATTA = Abbreviated Torrance Test for Adults.

A series of linear regression equations were used to determine whether the relationship between creativity and executive function was moderated by intelligence. PROCESS moderation models were chosen to compute such series of linear regressions. Due to missing data points, analyses that evaluate creativity and inhibition include a sample 51 participants each.

See Table 3 for significant moderation models. The interaction between intelligence and shifting significantly predicted creativity (*B* = -2.66, *SE* = 1.16, *β* = -.40, *p* = .03). Further, the interaction between crystallized intelligence and updating significantly predicted creativity (*B* = 1.13, *SE* = .54, *β* = -.28, *p* = .28).

Table 3

Significant Moderation Models of Creativity

Effect	Estimate	SE	95% CI for Estimate LL	95% CI for Estimate UL	Standardized Estimate	*p*	Model R^2
Dependent Variable = Creativity							.21
Intercept	-1.40	1.12	-3.65	.08	0	.2149	
TMT B	2.09	.77	.55	3.64	.47	.0089	
ABIQ	3.36	1.63	.09	6.64	.26	.0444	
TMT B*ABIQ	-2.66	1.16	-4.99	-.33	-.40	.0262	
Note. N = 51							
Dependent Variable = Creativity							.16
Intercept	-.26	.85	-1.96	1.44	0	.7604	
ACT	2.05	.90	.23	3.86	.31	.0278	
VAIQ	.46	.56	-.67	1.60	.11	.4141	
ACT*VAIQ	1.13	.54	.04	2.22	.28	.0433	

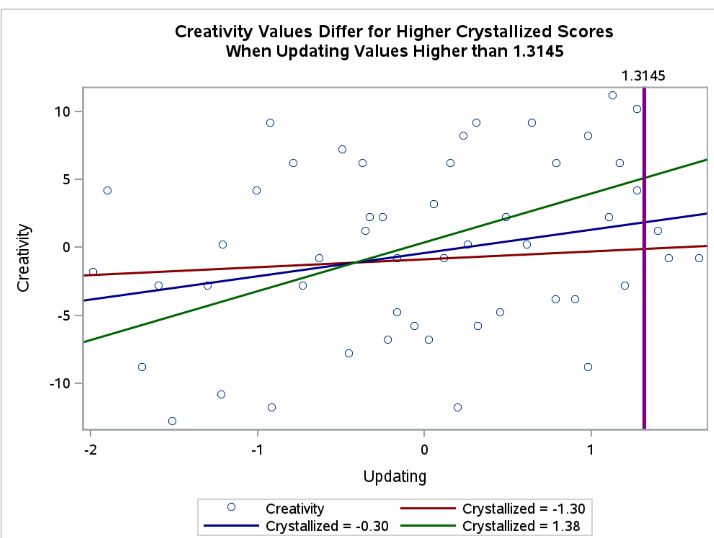
Note. N = 51

Regions of significance were evaluated for moderation models including the interactions between intelligence and shifting and intelligence and updating. According to the Johnson-Neyman technique in Figure 1, shifting significantly predicted creativity for those with a standardized shifting score less than .03. Specifically, among those with lower intelligence scores, shifting was positively associated with creativity when their shifting score was lower than .03. Alternatively, among those with higher intelligence scores, shifting was negatively associated with creativity when their shifting score was lower than .03. Shifting scores greater than .03 were not significantly associated with intelligence and creativity. According to the Johnson-Neyman technique in Figure 2, updating significantly predicted creativity for those with a standardized updating score greater than 1.31. Specifically, updating was positively associated with creativity among those with a crystallized intelligence score greater than one standard deviation above the mean. This relationship was more strongly positively associated than those with crystallized intelligence scores less than one standard deviation above the mean.

Figure 1

Note. N = 51. Data were centered.

Figure 2



Note. N = 51. Data were centered.

CHAPTER IV

DISCUSSION

The relationship between creativity, intelligence, and executive function has been explored, but findings have differed as to how these constructs are related and in what contexts. Variations in the measurement of these constructs have posed difficulty in our understanding of their complex relationships with one another.

It was predicted that measures of creativity, intelligence, and executive function would all be significantly positively correlated with one another. Aligning with this initial hypothesis, creativity was significantly and positively correlated with abbreviated intelligence, fluid intelligence, updating, and inhibition; although, crystallized intelligence and shifting did not demonstrate significant positive correlations. Crystallized intelligence and shifting were only significantly and positively correlated with other measures similar to their respective construct. Studies have demonstrated positive correlations amongst creativity, intelligence, and executive function separately, but few have found correlations across all three constructs to be positively correlated simultaneously. Similar to this study, a mixture of patterns across significant correlations were found. Amongst studies investigating all three constructs concurrently, crystallized (verbal) intelligence and creativity were positively correlated, but not executive function or fluid (nonverbal) intelligence (Taylor & Zaghi, 2021, 2022). Similarly, Pan and Yu (2016) found that intelligence and creativity were positively correlated with one another, but shifting was not. Alternatively, Benedek et al. (2012) demonstrated that all three constructs were positively correlated. Similarities between this study and studies conducted by Taylor and Zaghi

(2021, 2022) and Benedek et al. (2014) may be related to the utilization of comparable creativity and inhibition assessments. Benedek et al. (2014) also utilized the Stroop Color Word Test, although not administered digitally in the current study, to assess inhibition. Additionally, Taylor and Zaghi (2021, 2022) utilized the Torrance Tests of Creative Thinking to assess creativity; although similar, the abbreviated version (the ATTA) was utilized in the current study. Despite a lack of conformity amongst the nature of these correlations, these findings establish that a relationship between creativity, intelligence, and executive function does exist.

Additionally, it was predicted that intelligence would moderate the relationship between creativity and executive function. Partial support for this hypothesis was demonstrated with only specific types of intelligence displaying a significant moderating effect with creativity and executive function. Specifically, significance was found amongst the interactions between abbreviated intelligence and shifting, as well as with crystallized intelligence and updating. Furthermore, specificity amongst the intelligence categorizations, Low or High, was predicted to influence the strength and significance of the relationship between creativity and executive function. Moderating effects displayed a pattern of scores that denoted variations in such relationships between creativity, intelligence, and executive function. When evaluating low intelligence scores, shifting was positively associated with creativity when such scores were lower. Consequently, high intelligence scores demonstrated a negative association between shifting and creativity when executive function scores were also low. These results suggest that individuals with an intelligence score below 100 who performed below average on the shifting task actually demonstrated high creativity, which appears counterintuitive. Further investigation of this type of relation is warranted. For example, is this relationship a reflection of when one area of the brain (e.g., left frontal lobe) is experiencing decreased functioning, a proximal area is activated (e.g., right frontal, left parietal)? It also may be that more detailed analyses of the creative indicators could specify a more exact aspect of creativity that is impacted by the combination of lower intelligence and shifting abilities. With respect to updating and crystallized intelligence, all observed associations were positive, yet differences emerged with scores that varied from the mean. Higher crystallized intelligence scores displayed a stronger positive association with updating and creativity than lower crystallized intelligence scores.

Similar to the current study, the relationship between all three constructs was explored as a function of intelligence moderating creativity and executive function. When creativity was traditionally scored, fluid intelligence significantly moderated the relationship between creativity and executive function, although crystallized intelligence did not. Variations in these relationships arose amongst differences in fluid intelligence scores. A positive relationship was found between executive function and creativity when fluid intelligence scores were high. Lower executive function scores were associated with higher creativity scores and higher fluid intelligence (Taylor & Zaghi, 2021). Opposing this perspective, Pan and Yu (2016) analyzed this interaction as intelligence exhibiting a mediating effect on the relationship between creativity and executive function. In their case, shifting was predictive of creative ability despite a low correlation between the two. Alternatively, executive functioning abilities were utilized as mediators in exploring the relationship between intelligence and creativity. With executive abilities acting as mediators, fluid intelligence was predictive of creativity (Nusbaum & Silvia, 2011). Benedek et al. (2014) demonstrated that updating was predictive of fluid intelligence alone and updating and inhibition were predictive of creativity.

Similarities and discrepancies amongst this investigation have emerged regarding the relationship between creativity, intelligence, and executive function. Ultimately, variations in methodology and assessments have posed difficulty in narrowing the nature of this relationship. Including the current study, a multitude of differing perspectives have been taken with the intent of comprehending how these three constructs are related including identifying intelligence as a moderator (Taylor & Zaghi, 2021, 2022) – as this current study did – or as a mediator (Pan & Yu, 2016), as well as conceptualizing executive function indistinctly or by establishing it as a mediator (Nusbaum & Silvia, 2011). Furthermore, inconsistencies in the methods and assessment of each construct have presented differences in findings. The current study and others have chosen to define and identify multiple aspects of executive function simultaneously, while others have only assessed specific aspects. It is worth noting that the current study and Benedek et al. (2014) utilized the Stroop Color Word Test to assess inhibition, and both found that this executive function was predictive of creativity. In addition, both studies demonstrated that updating was also predictive of creativity; although, the manner in which updating and creativity were measured differed. The present study found that updating only significantly predicted creativity when crystallized intelligence was specified. Although shifting was the only aspect of executive function assessed (Pan & Yu, 2016), the current study also found that shifting was predictive of creativity; however, the current study demonstrated that this was only present when abbreviated intelligence was specified.

Like executive function, the manner in which intelligence was identified differed within previous research. For the purpose of this study, an overall (abbreviated) intelligence score, a verbal abbreviated score, and a nonverbal abbreviated score were collected and analyzed. Fluid intelligence was more often used within the literature with it being the only aspect of intelligence assessed (Benedek et al., 2014; Nusbaum & Silvia, 2011; Pan & Yu, 2016), while a total intelligence score was assessed in one study (Benedek et al., 2012). Alternatively, Taylor and Zaghi (2021, 2022) gathered two scores, a total verbal score and a total figural score with no overall score. Perhaps differences in findings from the current study may be attributed to test selection differences and what was chosen to be investigated. Higher crystallized intelligence scores demonstrated significance in the relationship between creativity and updating. This lack of consistency amongst the literature is attributed to the abundance of research and exploration into the fluid intelligence aspect of intelligence, in that it has been the most implicated within the interaction between all three constructs. Considering Taylor and Zaghi's (2021, 2022) findings and their conceptualization of intelligence, crystallized (verbal) intelligence was found to be significantly implicated more frequently than fluid intelligence as specific patterns of scores arose. Perhaps, conceptualizations of intelligence that include separate scores for fluid and crystallized intelligence yield more variation in overall findings due to their underlying differences in functions not being masked by a total score when analyzed with measures of creativity and executive function.

With creativity being the focus of the current study, emphasis should be placed on the vast ways that this construct has been assessed in the literature. For the purpose of this study, a total score was obtained in which it reflected a sum of the creative indicators (fluency, originality, elaboration, and flexibility). Additional data was gathered including scores for each of the creative indicators, but they are not analyzed here. Amongst those that did pursue the investigation into how these creative indicators differ in their portrayal of creative ability, differences arose based on which aspects of creativity were chosen. Some explorations into creativity included four aspects (Taylor & Zaghi, 2022), three aspects of creativity (Benedek et al., 2012; Pan & Yu, 2016), or just one (Benedek et al., 2014). Perhaps, differences in the rendering of creative potential have been influenced by the scoring methods of creativity tasks. Benedek et al. (2012) used a compounded total creativity score while others used separate totals of single tasks (Benedek et al., 2014; Nusbaum & Silvia, 2011; Pan & Yu, 2016) or calculated a total verbal score and a total figural score with no overall total (Taylor & Zaghi, 2021, 2022). These creative tasks varied from containing a single task with a "be creative" prompt to an assessment with multiple tasks embedded, like the Torrance Tests of Creative Thinking.

Limitations and Future Directions

Although this study provided essential information to further understanding the relationship between creativity, intelligence, and executive function, there is still much to explore for future research. Due to the nature of this research, this investigation was constricted to a smaller sample size of which primarily shared similar demographic information. This constricted sample yielded a majority of Caucasian females in their freshman year. Although this limits the generalizability of these findings, the sample that was collected was appropriate for the purpose of this study. The current study intentionally sampled college students to potentially understand the relationship between these three constructs within individual functioning in an academic setting. The exploration into how creativity, intelligence, and executive function are associated may provide insight into how they may be implicated and utilized in the day-to-day activities of college students. It would be interesting to replicate the current study's methodology and test selection to observe if the interactions between all three constructs are modulated with a larger sample size of college students. Along with a larger sample size, it would be of importance to ensure that a broader range of intelligence is displayed amongst the sample to observe potential differences in findings with more variation within this construct. As this study's sample consisted of relatively average intelligence, the categorization of low and high intelligence was arbitrary and strictly relative to the scores in this sample. Replication of the current study with the same test selection would be of importance to maintain as similar results have been obtained presently as other studies utilizing the same measures of inhibition and similar measures of creativity. To promote consistency in measurement, it would be of importance to establish similar assessments for future research as findings have varied based on how each construct was measured. Through the assessment of creativity, information regarding additional aspects of creativity and the students' college majors were gathered in the current study, but not analyzed here. Future research should include all four creative indicators (fluency, originality, elaboration, and flexibility) in their analyses to appropriately make a comparison of creative potential across the literature, as this has been relatively inconsistent. Additionally, comparison across the different college majors may provoke an interesting investigation into how the utilization of these three constructs may vary based on the relevant skills needed for success in these majors. With approximately sixty-four percent of this sample consisting of females, it poses a question of if brain differences amongst the genders contributed to the results obtained from the current study. Perhaps further investigations should explore such differences with a more balanced sample across sex as such differences may further moderate the relationship between the three constructs.

The findings of the current study suggest that intelligence and executive function are somewhat important to creative potential, but their exact contributions are still unclear. Despite the aforementioned relationships, it is worth noting that these findings appear to be driving the exploration of what mechanisms may be underlying the interactions between creativity, intelligence, and executive function in specific ways. Perhaps strengths and weaknesses amongst the constructs may disrupt or support the ease with which creative responses are produced. Exploring the extent to which all aspects of intelligence investigated here moderate this relationship may provide beneficial information to understanding how these three constructs interact and how day-to-day behavior and performance of a college student may be shaped by their abilities. Future research should continue to explicitly assess these constructs to further narrow potential explanations of how these three constructs are connected, in what context are they more strongly associated, and if there are specific methods of measuring this relationship. Findings across the literature may emphasize that there are a multitude of possibilities and opportunities in which these interactions exist and support one another. Thus, this study further emphasizes the complex interactions between creativity, intelligence, and executive function.

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APPENDICES

APPENDIX A

Demographics

1. Please specify your age: __________

2. What gender fits you best?
   - ☐ Male
   - ☐ Female
   - ☐ Non-binary
   - ☐ Transgender
   - ☐ Gender fluid
   - ☐ Other

3. What ethnicity do you identify with?
   - ☐ Caucasian/White
   - ☐ African American/Black
   - ☐ Asian/Pacific Islander
   - ☐ Hispanic/Latino
   - ☐ Other

4. What is your current college year?
   - ☐ Freshman
   - ☐ Sophomore
   - ☐ Junior
   - ☐ Senior
   - ☐ Graduate Student
   - ☐ Not Applicable

5. What is your current college major? ____

6. Do you have a history or traumatic brain injuries (TBIs) including concussion, head injury with a loss of consciousness, or stroke?
   - ☐ Yes
     - i. If yes, please specify: ____
   - ☐ No

7. Please check any of the following prescription medications that you are currently taking:

☐ Elavil, Vanatrip (*Amitriptyline*)
☐ Adderall (*Amphetamine/Dextroamphetamine*)
☐ Khedezla, Pristiq (*Desvenlafaxine*)
☐ Cymbalta, Yentreve (*Duloxetine*)
☐ Ritalin, Concerta, Delmosart, Equasym, Medikinet (*Methylphenidate*)
☐ Allegron, Aventyl, Noritren, Norpress, Nortilen, Norzepine, Pamelor, Sensoval (*Nortriptyline*)
☐ Maxitram, Marol, Zydol, Zamadol, Tramulief, Tramquel (*Tramadol*)
☐ Vensir, Vencarm, Venlalix, Efexor, Venlablue (*Venlafaxine*)
☐ Other. Please specify: ___________________________________
☐ I do not currently take any of these prescribed medications.

APPENDIX B

MTSU IRB Approval Letter

Office of Research Compliance
2269 Middle Tennessee Blvd.
Sam H. Ingram Bldg (ING) Room 010A
Box 124
Murfreesboro, TN 37132
www.mtsu.edu/irb

Date: April 24, 2024

PI: Jamie Adkinson
Department: Middle Tennessee State University, Psychology
Re: Initial - IRB-FY2024-233
Creativity and Cognitive Abilities: How are They Related?

The Middle Tennessee State University Institutional Review Board has reviewed and approved by Expedited Review the above referenced research study. The approval is effective starting April 24, 2024.

Decision: Approved
Category: 7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.)

Findings:
Research Notes:
The following apply to your approved study:

1. In accordance with 45 CFR 46.110 and the regulations for Expedited Review (Common Rule), this project does not expire and continuing review is not required by the IRB.
2. Any unanticipated harm to participants or adverse events must be reported to the Office of Compliance.
3. All modifications to the approved study must be submitted for review through Cayuse IRB for approval before their implementation. Adding new researchers constitutes a modification to the protocol. Per MTSU Policy, a researcher is defined as anyone who handles the data or interacts with participants. Everyone meeting this

definition for this project must have completed the required CITI training and received IRB approval prior to becoming actively involved in the project.

4. Closure of the study must be submitted within Cayuse when the study ends or when personal identifiers are removed from the data and all codes and keys are destroyed.
5. All research materials must be retained by the PI for at least three (3) years after study completion and then destroyed in a manner that maintains confidentiality and anonymity.
6. All approval letters and study documents are located within Submission Details in Cayuse IRB.

The Middle Tennessee State University Institutional Review Board

APPENDIX C

Informed Consent

Study Title: Creativity and Cognitive Abilities: How are They Related?
Protocol Number: IRB-FY2024-233
Approval Date: 4/24/2024
Principal Investigator: Jamie Adkinson
Institution: Middle Tennessee State University

Name of participant: ____ Age: _________

You are being asked to participate in a research project. The following information is provided to inform you about the research project and your participation in it. Please read this form carefully. You will be given an opportunity to ask questions, and your questions will be answered. Also, you will be given a copy of this consent form.

Your participation in this research study is voluntary. You are free to withdraw from this study at any time with no penalty and no loss of benefits already earned. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision about whether or not to continue your participation.

1. Purpose of the study: **The purpose of this research project is to learn more about the relationship between creativity and cognitive ability in college students. You will be asked to participate in a variety of assessments that will facilitate an investigation into how creativity and cognitive abilities are related.**

2. Description of procedures to be followed and approximate duration of the study: **Upon consent to participate in the study, you will fill out a form relating to demographic information about yourself. Next, you will complete five assessments that measure your creativity and cognitive ability. The approximate duration of this study will be 45 to 60 minutes.**

3. Expected costs: **There are no expected costs to you for your participation.**

4. Description of the discomforts, inconveniences, and/or risks that can be reasonably expected as a result of participation in this study: **There are no known risks associated with participating in this study. You can expect to experience the same things as you do any day while engaging in academic tasks.**

5. Compensation in case of study-related injury: **We do not provide compensation in cases of any potential injury. No injury is expected.**

6. Anticipated benefits from this study:
a) The potential benefits to science and humankind that may result from this study include contributions to psychological research's understanding of how creativity and cognitive abilities may be related in a college student population.

b) The potential benefits to you from this study include receiving research credits or extra credit from your professor for your class. There are no other direct benefits to you.

7. Alternative treatments available: **No treatments or interventions are included in this study.**

8. Compensation for participation: **For participating in this study, you have the opportunity to receive extra credit at the discretion of your professor. If you are participating in this study through the Psychology Research Pool, then you are eligible to receive 2 research credits. No monetary compensation will be provided.**

9. Circumstances under which the Principal Investigator may withdraw you from study participation: **There are no circumstances under which you will be withdrawn from the study.**

10. What happens if you choose to withdraw from study participation: **Your participation in this research study is voluntary. You may withdraw your participation in this study at any time. There will be no penalty to you upon your decision to withdraw from this study.**

11. Contact Information: If you should have any questions about this research study or possible injury, please contact:
Principal Investigator: Jamie Adkinson
Contact Information: jra7d@mtmail.mtsu.edu
Faculty Advisor: Dr. Kimberly Ujcich Ward
Contact Information: Kimberly.ward@mtsu.edu
For additional information about giving consent or your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance at 615-494-8918 or via email at irb_information@mtsu.edu. (http://www.mtsu.edu/irb)

12. Confidentiality: All efforts, within reason, will be made to keep the personal information in your research record private, but total privacy cannot be promised. Your information may be shared with people at MTSU (such as the MTSU Institutional Review Board) or other agencies (such as the Federal Government Office for Human Research Protection) if you or someone else is in danger or if we are required to do so by law.

13. STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY

I have read this informed consent document and the material contained in it has been explained to me. I understand each part of the document, my questions have been answered, and I freely and voluntarily choose to participate in this study.

_______________ ____

Date Signature of participant

Consent obtained by:

_______________ ____

Date Signature

____

Printed name and title