2018

Creating Divergence: Examining The Development Of Creativity Through Executive Function, Language And Mindset

Brittany Nielsen Avila
University of Mississippi

CREATING DIVERGENCE: EXAMINING THE DEVELOPMENT OF CREATIVITY THROUGH LANGUAGE EXECUTIVE FUNCTION AND MINDSET

A Dissertation
presented in partial fulfillment of requirements
for the degree of Doctor of Philosophy
in the Department of Psychology
The University of Mississippi

by

BRITTANY NIELSEN AVILA

May 2018

ABSTRACT

Creativity is a multifaceted construct influenced by task constraints (Glucksberg & Wesiberg, 1966; Runco, 1986), cognitive processes (Bijvoet-van den Berg, & Hoicka, 2014; Claxton, Pannells, & Rhoads, 2005) and motivational factors (Dweck, 2006; Lucas & Nordgren, 2015), and is hypothesized to have significant "slumps" where the development slows, such as the "fourth-grade slump" (Torrance, 1967; 1968). The purpose of the present study was to examine the hypothesized "fourth-grade slump" in creativity and determine whether cognitive factors, such as executive function (i.e., cognitive control, Zelazo, Muller, Frye & Marcovitch, 2003), motivation factors (i.e., mindset and persistence), and situational factors (i.e., language used within a task) would interact with age to show different patterns of influence during different times of development. Although there was not a fourth-grade slump, we did find differences between children and adults where children had lower creativity but showed links to EF abilities in working memory. People at all age groups undervalued their persistence in a creative task and mindset was not related to creative ability. Taken together, these results indicate that children utilize cognitive factors such as EF when performing a creative task and as people age they rely less on cognitive factors, but have overall higher levels of creativity and all age groups undervalue the role of persistence in creative tasks.

DEDICATION

This work is dedicated to Cheri Verrastro, without whom none of this would be possible. Thank you for always believing in me.

LIST OF ABBREVIATIONS AND SYMBOLS

AUT Alternative Uses Task

BDS Backward Digit Span

DCCS Dimension Change Card Sort

DoG Delay of Gratification

ACKNOWLEDGEMENTS

I would first like to thank Dr. Stephanie E. Miller for all of her tireless dedication to this project and endless patience through all the revisions. Without her this dissertation and this degree would not be possible. To my committee members, Dr. Matthew Reysen, Dr. Elicia C. Lair and Dr. Kara E. Hawthorne for reading multiple drafts and preparing me for a career in academia. Thank you to my research assistants, Kristin Carpenter, Lindsey Clark, Victoria Mathias, Briana Medina, Melissa Miller, Saraid Racicot and Julianne Quinn, for making this possible and a special thank you to Kristin Barnett for being the sole reason we finished collecting data so quickly. To my fellow lab-mate who never tired of listening to me go on about my dissertation no matter how many times I revised it, Tonya Vandenbrink.

I would also like to thank those in my personal life who helped make this happen. My mother, Cheri Verrastro, for believing in me even when I lost faith in myself and helping through this journey no matter how long it took. My husband, Scott, for standing by me and working so hard so that I could pursue my dream. This would not be possible without you, thank you. My son, Lucas and my unborn son, for giving me the strength and determination every day to keep going. Lastly, thank you to my sister, Jenna Mills, for always editing my emails, drafts and ideas and keeping me sane. Without everyone here this would still be a single sentence in a word document. Thank you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

To find creativity in the world (i.e., works that are both novel and useful, Sternberg & Lubart, 1999) one does not need to look far. The computer you are likely using to read this was once just a creative idea far from being realized. Though creative works are ubiquitous today (i.e., cellphones, computers, endless applications for those devices and great works of art such as novels, paintings, and even movies), understanding creative development and the factors that influence creativity remains elusive. Creativity is thought to emerge as early as 2 years of age (Bijvoet-van den Berg & Hoicka, 2014; Hoicka, Bijvoet-van den Berg, Kerr, & Carberry, 2013) and increases until fourth grade when we see a sharp decline in creative achievement known as the fourth-grade slump (Claxton et al., 2005; Kim, 2011; Nash, 1974; Torrance, 1968). Few studies have examined underlying causes of this decline, though researchers have suggested the fourth-grade slump is caused by a change in the language and instructions used in the classroom as well as an increase in cognitive ability (Runco, 1986; Torrance, 1968). The current study examined how changes to language used within a creativity task influenced creative responses across the lifespan at first grade, fourth grade, and adulthood. Further, I explored how individual differences in cognition (e.g., using executive functions to hold more than one idea in mind at once) and motivation (e.g., believing that your creative ability can improve through hard work) related to creativity and the use of language in creative tasks. Through language and individual difference variables we can gain a better understanding of the development of creativity across the lifespan.

Theories of Creativity

Most theorists agree that creativity is defined as an ability to produce work that is both novel and useful (Albert & Runco, 1999; Guilford, 1950; Runco, 1986; Sternberg & Lubart, 1999). For example, the invention of the personal computer can be considered a creative work because it was a unique addition to technology that has proven to be useful, with most people unable to go a day without using one. One of the major theories of creativity is the investment theory proposed by Sternberg and Lubart (1995) who suggested that creative people “buy low and sell high” like good investors do. According to their theory, a creative individual will first generate ideas that are unpopular, buying low (e.g., the personal computer was met with skepticism and criticism because a home computer was not seen as necessary or useful). Second, creative people will attempt to convince other people that their ideas have worth (e.g., advertising the need for a computer at home). Lastly, they sell high letting other people pursue their ideas while they move on to the next unpopular idea (e.g., cell phones or laptops, Sternberg & Lubart, 1995; Sternberg & O’Hara, 1999). Creativity production has been suggested by many to operate in this fashion, with creative individuals finding an unexplored area where they can invest low and explore potentially unpopular ideas that will yield a large payoff if they can convince others of their need.

Within the investment theory, Sternberg and Lubart (1995) propose six personal factors needed for creative achievement. The first, intelligence, has three aspects associated with creativity: (1) synthetic ability – the ability to generate ideas that are novel and high in quality, (2) analytical ability – the ability to judge the value of one’s own ideas and whether they are worth pursuing, and (3) practical ability – the ability to apply intellectual skills to everyday situations (Sternberg & O'Hara, 1999). All three of these aspects are important for creative achievement. For example, someone may be very good at thinking of new and unique ideas (i.e., synthetic ability), but may lack the ability to determine which of those ideas are worth pursuing and which are not (analytical ability) and thus may spend too much time devoted to unworthy ideas. Or they may lack practical abilities like being able to communicate their ideas to others. The second factor from the investment theory is knowledge. To achieve creatively one must have knowledge of what already exists and what people think about or their conventional notions (Sternberg & Lubart, 1995). A creative product must be unique and thus to create it, one needs to know whether that product already exists or has been attempted before. Yet the authors also caution that too much knowledge can hinder creative productivity. For example, knowing about an object's original purpose can lead to declines in new and unique ways of viewing that item, known as functional fixedness (Adamson, 1952). Third, thinking styles are important to creative achievement. Thinking styles are ways in which people prefer to apply their knowledge and intelligence to a given problem. (Sternberg & Lubart, 1995; Sternberg, 1988). For example, a person may have a "legislative style" in which they prefer to handle tasks in their own way or an "executive style" where someone prefers a task specifically defined for them (Sternberg & Lubart, 1995). The fourth factor is personality. To achieve creatively a person must be willing to take risks and go against the status quo when buying low on an unpopular idea. Further, they must be courageous enough to stand up to people who believe the idea to be unnecessary or unworthy. The fifth factor is motivation. A creative person needs both intrinsic motivation (i.e., personal desire or self-expression) and extrinsic motivation (i.e., money or power) in order to concentrate on the task (Sternberg & Lubart, 1995). Lastly, a person needs the right environmental context. A person can have all other five aspects for creativity, but be in an environment that does not allow creative ideas (e.g., a classroom where the teacher discourages new or unique ideas).

Creativity Measurement. The study of creativity began by measuring eminent artists or scientists such as Picaso or Einstein. These people were hard to come by though and many researchers studied them posthumously making inferences difficult (Sternberg & Lubart 1999). Studying only famous creative individuals, and posthumously at that, limited the study of creativity according to Guilford (1950) by not allowing a full view of how creativity can interact in everyday situations. Therefore, Guilford proposed the use of a more psychometric approach involving tasks that could be quantified much like the IQ tests for intelligence and created several paper-and-pencil tasks including the Unusual Uses Task (also known as the Alternative Uses Task), where a person identifies as many uses for a common object (e.g., a brick) as they can (Guilford, 1975), allowing creativity to be exhibited by any person at any time. The scoring for this task is based on several factors that Guilford identified as being involved in creativity. The first factor, sensitivity to problems, is the ability to recognize that a problem exists. In the Alternative Uses Task example, this would represent knowing that we need to use a brick for a unique reason such as using it to hold a door open while we bring in groceries. Sensitivity to problems utilizes the analytic abilities described by Sternberg and Lubart (1995) where someone must recognize a problem and judge whether their own ideas to solving the problem are useful. The second factor is fluency, or the number of ideas generated. Someone scoring high on fluency would generate multiple unique ideas to use a brick. The third is flexibility or shifting approaches. To score high on flexibility each of the unique ideas generated needs to be in a different category. For example, using the brick as a doorstop would be in a different category than using it as a weapon. However, using the brick to hit your sister would be in the same category as using it as a weapon. Flexibility utilizes Sternberg and Lubart's (1995) practical ability of applying creative solutions to everyday situations. Specifically, to be considered flexible a person must switch between possible uses (situations) for each item. The last factor is originality or determining whether a use for an item is novel (e.g., synthetic abilities, Sternberg & Lubart, 1995). Using the brick to hold a Barbie funeral would be considered more original than using it as a weapon (Guilford, 1975). Other measures were developed drawing off of Guilford's concepts of creativity (Houtz & Krug, 1995; Kim, 2011; for a review see Zeng, Proctor & Salvendy, 2011) with the Torrance Tests of Creative Thinking (TTCT, Torrance, 1974) as perhaps the most popular method. The TTCT consists of two parts: a verbal scale where people are asked to generate numerous ideas to problems posed (e.g., stating different ways to use a conventional object such as a brick), and a figural scale where people actually produce creative works (e.g., completing a drawing). With this suggestion of using psychometric measures, the field took off in studying creativity psychometrically looking at what is known as divergent thinking, the ability to produce many unique solutions to a single problem as opposed to convergent thinking where one answer is required of the problem (Bijvoet-van den Berg, & Hoicka, 2014; Claxton, Pannells, & Rhoads, 2005; Roskos-Ewoldsen, Black, & Mccown, 2008; Runco, 1999).

As the field of creativity shifted to understanding psychometric measures of creativity, individuals began to question the extent that measuring divergent thinking accurately assessed creativity. Whereas creativity is the ability to produce something that is both novel and useful

(Sternberg & Lubart, 1999), divergent thinking is the ability to produce multiple unique solutions to a single problem (Runco, 1999). Thus, divergent thinking may be thought to be a portion of creativity as it measures unique and novel ideas, but does not inherently capture what is useful. Although some researchers still believe that the best way to measure creativity is to use actual creative works that have shown to be useful in society (i.e., popular novels or works of art; Charles & Runco, 2001; Kim, 2011; Zeng, Proctor, & Salvendy, 2011), the majority of researchers use divergent thinking to better understand creativity due to the difficulties acquiring and measuring creative works (Bijvoet-van den Berg, & Hoicka, 2014; Charles & Runco, 2001; Claxton, Pannells, & Rhoads, 2005; Kim, 2011; Roskos-Ewoldsen, Black, & Mccown, 2008; Runco, 1999; Sternberg & Lubart, 1995; 1999; Sternberg & O'Hara, 1999). Divergent thinking tests also have an advantage over achievement-oriented measures in that it does not penalize for lack of expertise of productivity making it especially useful with children (Charles & Runco, 2001).

Development of Creativity. Research on divergent thinking has been conducted throughout the lifespan and this aspect of creativity has been found to emerge around 2 years of age (Bijvoet-van den Berg, & Hoicka, 2014) and increase thereafter with specific "slumps" during childhood and adolescence (Barbot, Lubart, & Besancon, 2016). Torrance (1967; 1968) described marked declines in creativity at three different time periods throughout life. The first slump occurs around preschool at about age 5. The next decline occurs around age nine, known colloquially in literature as the fourth-grade slump and the final slump occurs in adolescence around age 12 and then the development begins to level off in a slow decline until late adulthood (Torrance, 1967; 1968). However, there is disagreement on when exactly these slumps occur.

For example, Kim (2011) suggested that rather than a fourth-grade slump, the major decline occurs in the sixth grade, Charles and Runco (2011) suggested a peak in fourth grade rather than a slump, and Claxton, Pannells, and Rhoads (2005) found no significant decreases in creativity from fourth to ninth grade (except an increase in elaboration ability from sixth to ninth grade). The curvilinear nature of creativity is consistent with developmental theories (Charles & Runco, 2001) that suggest sharp increases and declines in creativity throughout the lifespan. Though the exact age at which the slumps occur is being debated, the fourth-grade slump was one of the first discovered and therefore has become the most studied decline (Barbot et al., 2016).

Explanations given for the various slumps tend to focus on an increase in convergent thinking (i.e., finding the single best answer to a problem or question; Cropley, 2006). For example, Kim (2011) argued that children's ability to produce multiple ideas (fluency) decreases around fourth grade due to children becoming more concerned with representational accuracy than with creative output. For example, children may be more concerned with guessing the use for the object considered most correct by others (i.e., they would want to say that a brick was used to build a house, because that is what most people would think). Charles and Runco (2001) also suggest that creativity declines as children begin to understand which ideas other children would think of and which are appropriate; suggesting that if convergent thinking is valued by others it will be preferred to divergent thinking in children. The desire to reach representational accuracy is seen most clearly in standardized tests for children, where children are asked to select the most appropriate answer to each question. This emphasis on convergent thinking in standardized testing has become a popular theory among researchers to explain declines in creativity. For example, Kim (2011) argues that an increase in standardized testing and the language used for instructions contributes to declines in creativity because it encourages children to shift emphasis toward rote learning and memory and away from creative solutions. Sternberg and O'Hara (1999) agree with Kim, stating that creative students are not benefiting from instructions given in school because they are focused more on memory and analytical abilities and less on the more important synthetic abilities of finding multiple solutions. Most notably, in 1968 Torrance hypothesized that the school environment (i.e., value of convergent thoughts over divergent ones) and the need to pay attention to school rules around fourth grade attributed to the slumps. Other environmental factors such as parental practices (Mourgues, Barbot, Tan & Grigorenko, 2014), cultural factors (Dahlman, Backstron, Bohlin, & Frans, 2013) and experiences (e.g., parental death or poverty; Damian & Simonton, 2015) have been proposed to contribute to declines in creativity. However, these explanations emphasizing environment's role in stressing convergent over divergent thinking have remained largely theoretical without empirical studies to support them.

Factors that Influence Creativity

Labeling. What is common across the explanations for creative decline is the role that language can play in communicating a convergent thinking emphasis (e.g., instructions leading children to think more convergently; Glucksberg & Weisberg, 1966; Kim, 2011). Research on functional fixedness has, for example, explored how using labels can influence creativity. Taking the emphasis off a leading label in a functional fixedness task can aid in more creative solutions to a problem. More specifically, Glucksberg and Weisberg (1966) examined labels in the classic "candle problem", in which adults were given a candle, a book of matches, and a box of thumb tacks and asked to find a way to affix the candle to a wall. In the standard condition, participants were given a picture where the box of tacks was only labeled as “tacks” and the box becomes a functionally fixed object in that most people do not see it beyond its use of holding the tacks. Whereas in the label condition participants were given a picture in which the box and the tacks were labeled separately, and with this additional label participants were more likely to use the box on its own to achieve the goal of the task to tack the box to the wall to hold the candle (Glucksberg & Weisberg, 1966). Having a label for each item increased creativity because people are better able to think about the purpose of each item individually rather than grouping them together. When grouped together it is harder to think of using the box as anything except for holding the tacks, whereas when we label them separately it becomes easier to think about using the box for another purpose.

Work with labels in functional fixedness suggests that the type of label used on functionally fixed objects can influence performance on divergent thinking creativity tasks. However, this work has been conducted primarily with adults and within the realm of a functional fixedness task. Research with children show that children become more susceptible to functional fixedness as they age. Children as young as 6 and 7 years old have been shown to struggle with functional fixedness, whereas younger children aged 5 years seem to be immune to the phenomenon (German & Defeyter, 2000). It is possible that these young children are immune to functional fixedness because they have learned that items can have multiple labels (Waxman & Hatch, 1992), but have not yet become overly concerned with finding an appropriate label accepted by their teachers or parents (Kim, 2011). Therefore, school-age children may be able to understand multiple labels for objects, but are more likely to search for the most appropriate label that other peers, parents or teachers want them to use. Work points to the hypothesis that one of the reasons children may begin to show a slump in school age is that they are given labels that promote convergent thinking as well as being taught to be aware of what labels are valued by teachers and peers (i.e., when asked to name an object the student knows the teacher prefers the label “brick”, this label then colors their interpretations of what you can do with that item, such as using it only as a “brick” and not as a “chair”). Thus, examining labels within a divergent thinking creativity task could be useful because labels may influence children to respond with more common uses for an item that they believe the researcher is searching for which may lead to lower performance on a divergent thinking creativity task. Because children are encouraged to think more convergently during the school years, these convergent labels may be especially influential during the fourth-grade slump (Charles & Runco, 2001; Kim, 2011). For example, recall that in divergent thinking tasks a child must come up with as many novel uses for an item as they can (e.g., a brick). Language theories would suggest that the label provided in this task will influence the way children solve this problem by bringing their attention to what the label represents (e.g., building a house), and filtering out all other possible alternative uses for the item, such as a chair (Kim, 2011; Waxman & Hatch, 1992). Therefore, making the labels within a task more ambiguous by using non-sense words, such as “pelganum” may be particularly helpful for school-age children leading to less influence of the more appropriate convergent labels they are used to for an object, such as “brick” when generating multiple novel uses for that object.

Executive Function. As detailed by Sternberg and Lubart (1995), there are several cognitive and motivational factors that influence creativity, and these individual difference factors may also interact with the possible “slumps” we see in creativity across development.

One possible cognitive process that has been linked to creativity is executive function or EF (Aziz-Zadeh, Liew, & Dandekar, 2013; White & Shah, 2006; Zabelina, & Robinson, 2010). EF is the cognitive control processes by which people regulate thoughts and behaviors (Zelazo, Muller, Frye & Marcovitch, 2003). EF has been proposed to exist in a unity/diversity framework (Miyake & Friedman, 2012) whereby different component processes are correlated with one another because they share a common EF related to representing task information to guide behavior. The first component, inhibition, is the ability to inhibit a prepotent response (e.g., delaying a small for a larger reward later). The second component known as cognitive flexibility is the ability to switch between multiple mental sets or rule sets (e.g., switching between sorting rules). Lastly, working memory is the ability to hold information in mind while manipulating it (e.g., repeating a series of number digits backward; Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000).

Considerations of EF components may be especially important to understanding creativity. All three components have been linked to creativity separately in adults. Young adults who score as highly creative have been found to have lower inhibitory control compared to those with lower creative ability, perhaps because this lack of inhibition allows them to access a greater number of stimuli or concepts during processing (Carson, Peterson, & Higgins, 2003; White & Shah, 2006). Zabelina and Robinson (2010) demonstrated that highly creative young adults had an unusually high level of flexibility (Zabelina & Robinson, 2010), likely because they are better able to determine when utilizing automatic processes is beneficial and should not be interrupted (e.g., congruent trials on a Stroop task where one must say a color word written on the screen and the color of the ink matches the word written, such as the word “green” written in green ink) and when it is better to switch to more consciously controlled system like EF (e.g., incongruent trials on a Stroop task where the color word and the color of the ink do not match, such as the word “green” written in yellow ink; Zabelina & Robinson, 2010). In working memory research, Aziz-Zadeh, Liew, and Dandekar (2013) demonstrated that divergent thinking was associated with the prefrontal cortex linked to working memory (Fuster, 2001), suggesting those with higher working memory do better on divergent thinking tasks because they are better able to mentally manipulate objects along varying dimensions necessary during divergent thinking tasks (e.g., mentally rotating three shapes, ‘C’, ‘0’, ‘8’ to form a recognizable object like a smiley face; Aziz-Zadeh, Liew, & Dandekar, 2013). EF is still developing in school-age children and thus may influence creativity differently at this age, yet no one has examined EF effects on creativity in children.

Mindset and Persistence. As with cognitive factors, personality and motivation factors are also important to creativity because they can help individuals overcome obstacles and persist through difficult creative tasks. Intrinsic motivation, or motivation that is centered within an individual, has been shown to be especially important to fostering creativity (Amabile,1985). Perhaps the most influential work on intrinsic motivational styles belongs to Carol Dweck (2006) and her two motivational frameworks, or mindsets, that set the stage for the way people view their abilities. The first is a fixed mindset where a person believes their abilities are static and cannot be changed (Dweck, 2006). For example, a person may believe they are not good at math and no amount of studying can improve this ability. A growth mindset, on the other hand, is someone who believes that they can change their abilities with hard work (Dweck, 2006). In this instance, a person would seek out difficult math challenges to help them learn and grow and not be discouraged by failures. Individuals with a growth mindset seek out challenges and thrive when problems become difficult, whereas those with a fixed mindset prefer to tackle problems that are easy for them to solve (Dweck, 2006). With this in mind, it is hypothesized that individuals with a growth mindset would persist longer during both convergent thinking problems and divergent creativity problems that are more difficult and ask them to stretch their imagination and solve problems in a different way, while those with a fixed mindset would persist only on easier convergent thinking problems where the solution is quicker to find.

Mindset has been linked to creativity and creative self-concepts as well. Karwowski (2014) found that a growth mindset was positively associated with creative self-concept (i.e., self-efficacy for creativity), and a fixed mindset was negatively related to efficacy when solving insight problems (i.e., solving a creative problem suddenly in an “aha” like experience) in adults (Bowden & Beeman, 1998). Susan O’Neill (2011) examined the mindsets of young musicians and discovered that many had been told they were “gifted” or “talented” repeatedly and developed a fixed mindset as a result, believing that their musical abilities lied in their static talent rather than in their hard work. When a growth mindset was fostered, however, these young musicians took more risks, performed better during concerts, and dealt with setbacks better than their fixed mindset counterparts. O’Neill’s research is in line with Dweck’s (2007) findings that verbal praise can hinder a growth mindset, and subsequently achievement, when directed toward the wrong things. Praise for static abilities, talents, and being “smart” lead to a fixed mindset, whereas praise for effort and hard work can nurture a growth mindset (Dweck, 2007), suggesting that mindset, like creativity, may be influenced by labels.

An important part of the growth mindset that may impact creativity is resilience or persistence. Generating novel and useful ideas is not always an easy or quick task. Persistence allows individuals to push through difficulties during the creative process. In a survey of 143 creativity researchers, Dweck (2006) found that the researchers consistently rated the factors of perseverance and resilience within a growth mindset as the most important factors contributing to creative achievement. Lucas and Nordgren (2015) provided more information on the role of persistence in creativity by demonstrating that persistence was a critical component of creative performance for adults even when people underestimated it. Specifically, in a series of studies, undergraduate participants were asked how many more responses they would generate on the Alternative Uses Creativity Task if they were allowed more time. Consistently, people indicated that they would likely not generate many more ideas if allowed more time even though they did in fact generate more responses and more creative responses on creativity measures after being allowed more time than on previous attempts, suggesting that people underestimate the value of persistence in creative achievement. These results reinforce the idea that persistence may be a leading factor contributing to creative achievement (Dweck, 2006) by demonstrating that when one persists through a difficult problem they are able to develop more novel creative solutions to a problem, even when they do not believe that they will.

The Present Study

Creativity is thought to have a curvilinear pattern of development with several sharp increases as well as quick declines with the most common decline occurring around the fourth-grade before leveling out in adolescence (Torrance, 1968). Children in first-grade, fourth-grade and adults were selected to coincide with popular trends in development and slumps in children.

Specifically, children in first-grade are thought to be experiencing an increase in creativity (Barbot, Lubart, & Besancon, 2016; Torrance, 1967), whereas fourth-graders are thought to be experiencing the most discussed slump (Barbot et al., 2016; Claxton, Pannells & Rhoads, 2005; Torrance, 1697). Adults are included in this sample for two reasons: (1) developmentally their creativity should have reached an asymptote after another increase during adolescence and (2) some studies using labels (Glucksberg & Weisberg, 1966), EF (Aziz-Zadeh, Liew & Dandekar, 2013; Zabelina & Robinson, 2010) persistence (Lucas & Nordgren, 2015) and mindset (Dweck, 2006) were not conducted within developmental psychology and therefore only utilized adult participants and the current study aims to replicate these results with adults while extending them to children.

Looking at divergent thinking creativity levels in the Alternative Uses Task, I examined the possibility of a fourth-grade slump and how individual differences in EF and mindset relate to creativity across the lifespan. First, I examined the developmental nature of creativity by hypothesizing that (1) children in first-grade would have the highest divergent thinking scores when given standard instructions on the Alternative Uses Task (Wallach & Kogen, 1965), followed by adults, then fourth-graders. Second, I looked at individual difference variables that contributed to baseline levels of creativity. Cognitive EF processes are thought to aid in developing creative thought through inhibition (e.g., less inhibition leads to the generation of more ideas, Carson, Peterson, & Higgins, 2003; White & Shah, 2006), cognitive flexibility (e.g., aid in the ability to switch from one way of thinking to another, Zabelina & Robinson, 2010), and working memory (e.g., allowing individuals to think about multiple items to come up with more creative solutions, Aziz-Zadeh, Liew, & Dandekar, 2013). Thus, I hypothesized (2) individuals with higher EF factors of cognitive flexibility and working memory would have higher divergent thinking ability, whereas inhibition would be negatively associated with divergent thinking across all age groups, but the strongest relationship would be seen in adults. Lastly, a person's mindset (e.g., fixed mindset where abilities are static versus growth mindset where abilities can develop and change) has been shown to be a significant personality variable important to creativity (Dweck, 2006; Lucas & Nordgren, 2015). Therefore, I hypothesized (3) individuals with a growth mindset would have higher divergent thinking scores than those with a fixed mindset across all age groups.

The fourth-grade slump has been theorized to occur due to strict instructions in school that promote convergent thinking and memory as opposed to divergent thought and creativity. In the present study, I also examined whether labels influenced children's creative thought related to the Alternative Uses Task. More specifically, in the Alternative Uses Task I provided children with either the typically presented non-ambiguous label hypothesized to encourage more convergent thinking leading children to the "appropriate" response for an ambiguous looking object (e.g., a lightbulb used to light a room), or an ambiguous label hypothesized to encourage less convergent thought (e.g., labeling the same item as a "pelganum" or "blicket" may encourage an unconventional or at least not prompt a prototypical convergent response). Objects presented were ambiguous looking so that participants would not be influenced by the look of the item rather than the label used. Using the different labeling conditions, I hypothesized that (4) though all age groups would have a slight increase in divergent thinking scores when given an ambiguous label (i.e., a "pelganum"), children in fourth-grade would benefit most because the ambiguous label would help fourth-graders overcome the search for the convergent answer and allow for creative solutions similar to first-grade levels. Further, I hypothesized that (5) for first graders, EF (cognitive flexibility and working memory, but not inhibition) would generally help them with creativity production, but would not depend on the types of labels used (i.e., ambiguous or non-ambiguous). However, for fourth-graders and adults, better EF ability would significantly help individuals become more creative when using a non-ambiguous label and would only have a slight impact when using an ambiguous label.

Finally, Lucas and Nordgren (2015) found that adults typically undervalue the effectiveness of persisting through divergent thinking tasks. The current study attempted to replicate these results demonstrated with adults and determine how children view their persistence during the divergent thinking task. Specifically, participants completed an Alternative Uses Task for one minute and then were asked how many more ideas they believed they could generate if given more time. As in Lucas and Nordgren (2015), individuals who believed they would generate less ideas were thought to undervalue persistence, whereas individuals who believed they would generate more ideas overvalued persistence. Looking at how many ideas participants believed they would generate, I hypothesized that (6) adults would undervalue their persistence and have higher levels of creativity than they estimated, whereas children in first- and fourth-grade would either overvalue their persistence or correctly estimate it. Previous research has demonstrated that children overestimate their abilities when comparing themselves to others (Butler, 1990), but research on how they view persistence on divergent thinking creativity tasks has not been done before. Further, (7) it is hypothesized that both children and adults with a growth mindset would correctly estimate or overvalue their persistence since they thrive on being given difficult problems where they can work harder for longer periods of time, whereas those with a fixed mindset would be more likely to undervalue persistence.

II. METHOD

Participants

Participants were 45 first-graders (*M* = 7.13, *SD* = .78; 23 girls and 22 boys), 41 fourth-graders (*M* = 9.95, *SD* = .80; 18 girls and 23 boys) and 100 adults (*M* = 19.05, *SD* = .89; 68 women, 31 men and 1 declined to state). Three first-graders were removed from analyses due to both peer interference (i.e., a friend told them to stop playing after receiving prizes) and inflated persistence scores (i.e., estimating they would generate 1,609 more responses to the divergent thinking creativity task), resulting in 42 first-graders included in the final sample. Removing these participants did not significantly change the demographic of the age group (*M* = 7.13, *SD* = .80, 21 girls and 21 boys). Participants were predominately white (first-grade: 83.3% White, 4.8% Hispanic, 11.9% did not state ethnicity; fourth-grade: 39% White, 61% did not state ethnicity; adults: 70% white, 18% African American 6% Asian/Pacific Islander, 3% Hispanic/Latino(a), 2% Mixed Race and 1% Indian/Hindu). Children in each age group were recruited from local schools and from the community in a small town in the Southern United States. Children received small prizes for participating. Children participated at multiple locations including: a laboratory on the University campus (32 participants), local elementary schools (53 participants) and a home visit (1 participant). At each location a child participated in a quiet room. Adults participated in exchange for course credit in an undergraduate psychology course at a medium sized University in the Southern United States. All adults participated in the same quiet room on the University campus.

Procedure

After obtaining parental consent and verbal assent (children) or signed consent (adults) to participate in the study, participants completed 3 EF tasks (i.e., Backward Digit Span, Dimensional Change Card Sort Task, and Delay of Gratification Task), measures of divergent thinking (i.e., Alternative Uses Task [AUT] baseline, AUT persistence and AUT label), a mindset questionnaire, and lastly the Wechsler Abbreviated Scales of Intelligence-Vocabulary measure of verbal IQ. These were presented in a fixed order to equate order effects, common of individual differences studies (Carlson & Moses, 2001).

Measures

Backward Digit Span (BDS). The backward digit span assessed working memory by having individuals hold digits in mind while reproducing them backward (Carlson, Moses, & Breton, 2002). Children were introduced to a puppet named "Leo the lion" who was a silly lion because he said numbers backward. In the training phase, children were instructed to repeat a string of two numbers backward (i.e., "if I say 1, 2, Leo would say 2, 1"). Children were then given two similar training trials in which they were corrected if they were wrong. Children had to independently answer what Leo would say on two different trials to pass training and move on to testing trials. If children did not pass the training phase (n=2) the testing phase was skipped, and children moved on to the next task. In the testing phase, children were presented with three two-digit trials and asked to produce the numbers backward. Next, the experimenter increased the digit span to three numbers and the procedure was repeated. The experimenter continued to give children three trials at each span before increasing the span by one digit. Testing was terminated once either the experimenter reached a seven-digit span (n=1) or children gave three incorrect answers in a row. Adults completed the same training phase and task, but began with a three-digit span instead of the two digits used for children and without the use of the lion puppet. Testing was terminated after three incorrect responses in a row. Adults had the opportunity to reach an eleven-digit span (though the highest digit span reached by any adult in the sample was nine). The highest digit-span where an individual had at least one correct trial (out of three trials) was measured.

Dimensional Change Card Sort (DCCS). This task measured cognitive flexibility by having individuals switch between multiple rules while sorting cards by color or shape (Zelazo, Frye, & Rapus, 1996). Children saw two sorting boxes on the lower edges of a computer screen consisting of a yellow flower and green car (see Figure 1). Children were then presented with six pre-switch trials in which they were asked to sort target cards (e.g., a yellow car or green flower) that appeared in the middle of the screen based on one dimension (e.g., color). Next, children were presented with six post-switch trials in which they were asked to switch and sort by a new dimension (e.g., shape). Finally, children were presented with 12 “borders” trials in which they were asked to sort by both color and shape in random order based on the border around the card (e.g., if the card had a border they sorted by shape, if not they sorted by color). The number of correct “borders” trials was measured for cognitive flexibility in children.

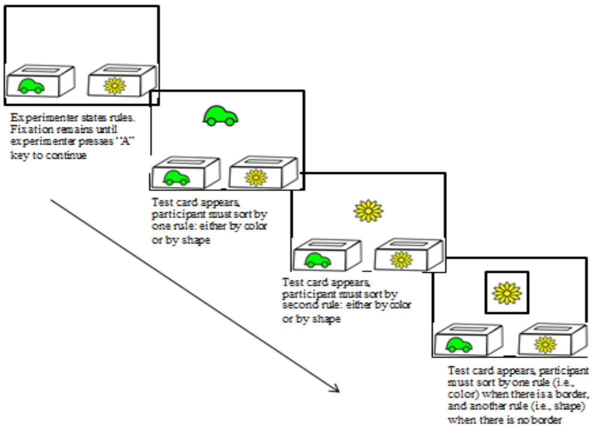

Figure 1. Diagram of the DCCS. Diagram by condition (pre-switch, post-switch, and borders or switch trials). Adults screen differ in two ways (1) the instructions for condition (i.e., the word "color" or "shape" for sorting condition) appear between the two boxes on the bottom of the screen and (2) there are no borders surrounding the test card during switch trials.

Adults completed a similar computer-based task where instructions for each trial (i.e., sort by color or shape) was written at the bottom of the computer screen rather than spoken aloud as in the children's task. Since instructions appeared at the bottom of the screen before each trial, there were no borders around each target card for adults. There were 12 pre-switch trials where participants sorted by one dimension (i.e., color) and 12 post-switch trials where participants sorted by another dimension (i.e., shape) and 24 "mixed" trials where participants had to switch between sorting by the two dimensions. The number of correct "mixed" trials was calculated as a measure of cognitive flexibility.

Delay of Gratification Task (DoG). Inhibitory control was measured by having children choose whether they preferred to receive a smaller reward at the time of the experiment or a larger reward once the experiment was over (Prencipe & Zelazo, 2005). A training phase was used in which the experimenter introduced children to the task by displaying a laminated card with pictures of an immediate reward on the left (e.g. one sticker) and a delayed reward on the right (e.g., eight stickers). The researcher explained that if they chose one sticker now, it would be placed into a plastic cup that they were able to play with immediately. However, if they chose eight stickers later, the stickers were placed into an envelope that they could have at the end of the experiment. The experimenter then demonstrated the task by making a now decision for 1 vs. 1 and a later decision for 1 vs. 8. Once the children were familiar with the process the researcher displayed one card at a time with the following ratios: 1 reward now vs. 2 later, 1 reward now vs. 4 later and 1 reward now vs. 6 later. The ratios were the same for three types of rewards: stickers, pennies and erasers. Nine trials were given and the total number of times the child chose to delay the reward was measured.

Adults completed a different DoG task that used a hypothetical scenario rather than stickers, pennies and erasers (Romer, Duckworth, Sznitman & Park, 2010). This task was used to be more relatable for adults than choosing between small rewards offered to children. In this task participants were asked about a hypothetical scenario in which they completed a job worth $500. Their employer then asked if they preferred to receive the $500 payment now, or if they would be interested in receiving $1,000 six months later. Depending on how the participant responded (either $500 now or $1,000 later) the amount increments changed accordingly. For example, if they chose $500 now initially, they were next asked if they would still choose to receive the money now if the job was worth $400, then $300, then $200, then $100. If they originally accepted the $1,000 later, they were asked if they would still accept the money later if the job would pay $900, then $800, then $700, then $600 later. The amount at which the participant decided to change their answer (or the final amount if they never changed their answer) was measured on a scale from 0 (always chose to accept the money now) to 9 (always chose to accept the money later).

Alternative Uses Task. The Alternative Uses Task (AUT) was used to measure divergent thinking because it has been widely used and is a reliable measure that is thought to be appropriate in measuring creativity (Houtz & Krug, 1995; Plucker & Renzulli, 1999; Torrance, 1968; Wallach & Kogan, 1965). Three different versions of the AUT were used in this study: AUT baseline, AUT persistence and AUT label.

AUT Baseline. The baseline version of the AUT followed the classic method used in Wallach and Kogan (1965) where individuals were given the following instructions:

> "In this game, I am going to name an object—any kind of object like a cup or the floor—and it will be your job to tell me lots of different ways that the object could be used. Any object can be used in a lot of different ways. For example, think about a string. What are some of the ways you can think of that you might use a string?" (*The experimenter lets the participant try*). "Yes, those are fine. I was thinking that you could also use the string to attach a fish hook, to jump rope, to sew with, to hang clothes on, and to pull shades." (*The experimenter varies her suggestions so as not to duplicate any the child has provided*.) "There are lots more too, and yours were very good examples. I can see that you already understand how to play this game. So let's begin now. And remember, think of different ways you could use the object that I name. Here we go."

Then individuals were asked to name as many unique uses for each item (i.e., a brick, a cardboard box, a shoe, and a chair) as they could to get a baseline of their creative ability. These items were selected after pilot testing with a group of younger children to determine which objects they would be familiar enough with to generate responses. Participants were given one minute to respond to each of the four items. Responses were coded based on fluency (number of items generated), flexibility (number of categories generated) and originality (percentage of novel responses based on sample). Coding for this task is discussed in detail below.

AUT Persistence. After the first minute, participants were asked "how many more uses could you come up with if given more time" to measure the value they place on persistence (Lucas & Nordgren, 2015). After responding, individuals were given another minute to respond with as many unique uses for the item as they could. Participants were asked to complete the AUT baseline measure for one word (i.e., brick) then asked about persistence, then completed the AUT persistence measure for the same word. Once participants completed all three tasks (AUT baseline, persistence question, AUT persistence) for the first word, they moved on to the second (i.e., cardboard box) and so on until they went through all four words.

AUT Label. The label version of the AUT again included instructions where the individual must name as many unique uses of an item as they can within one minute. Individuals were given one minute to complete this task to match the first minute allowed in the AUT baseline measure. Individuals were read the following instructions:

> "Ok, just like in the last game, I am going to ask you to come up with as many ways you can use an object as you can think of. In this game though, I am going to show you the object and you can look at it while you think."

However, in this task, half of participants were given instructions using ambiguous labels for items (i.e., "pelganum", "bup", "sharitnim", and "blicket"), whereas the other half of participants were given non-ambiguous labels for items (e.g., "dinosaur", "car", "bubble wand", and "light bulb"). The name of each item was read aloud to each participant (i.e., "this is a 'pelganum/dinosaur', how many different ways could you use this 'pelganum/dinosaur'"). Participants in both the ambiguous label condition and the non-ambiguous label condition were shown an object that can be seen to match the description of the non-ambiguous label for each object but is ambiguous enough that it can be seen as something else if given the ambiguous label (see Figure 2). In this task, participants were shown an object to examine whether answers to the unique uses were similar or different depending on the label used (i.e., does a person give the same uses for a "dinosaur" as they do for a "pelganum"). Having a tangible object to represent the item in both conditions allows for variability to be attributed to the label and not the object itself. The items were shown in the same order to each participant whether they were given an ambiguous or a non-ambiguous label to account for ordering effects. If a participant asked for clarification on what a certain word meant in either condition the experimenter simply said, "just do the best you can, how many different ways can you use this (label of item)". Again, the fluency, flexibility and originality scores were used as three dependent variables for AUT label.

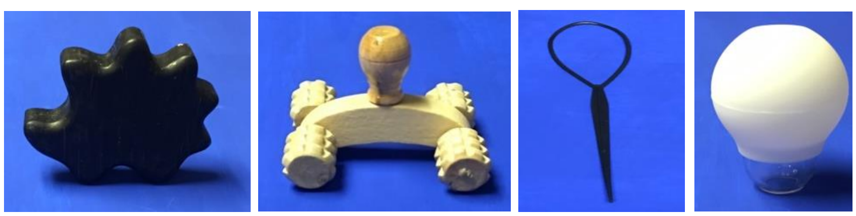

Figure 2. AUT objects. Objects used in second version of the AUT task. Labels for each object for both the ambiguous and concrete condition are as follows: (1) "pelganum" or "dinosaur" (2) "bup" or "car" (3) "sharitnum" or "bubble wand" and (4) "blicket" or "light-bulb

Coding of the AUT. There are four ways to measure divergent thinking on the AUT: fluency, flexibility, originality and elaboration (the amount of detail that is given during the response; Wallach & Kogan, 1965). Most researchers do not examine elaboration unless it is a direct research question (Bijvoet van den Berg & Hoicka, 2014, Hocevar & Michael, 1979, Hoicka, Bijvoet-van den Berg, Kerr & Carberry, 2013; Runco, 1986), since I was interested in the amount (fluency) and originality of responses more than the detail provided during responses, the current study only examines fluency, flexibility and originality.

Fluency was calculated for each of the creativity variables in this study: AUT baseline, AUT persistence and AUT label. Responses (i.e., each alternative use the participant stated) to the AUT were digitized by researchers using Microsoft Excel. Fluency for each item was calculated by adding all responses for that item on the AUT. If an item was repeated in exact or near exact terms such as “build a house” and “build house”, the item was only counted once (e.g., given a score of “1”) toward fluency so that only unique items were calculated. Items that were similar, but not exact were counted as separate items. For example, if someone said, “build a house” and “build a wall” those would be counted as separate items (e.g., give a score of “2”; Dippo & Kudrowitz, 2013). A total fluency score for each item was measured. Descriptive information for fluency of all participants can be found in Table 1. Participants were allowed to skip questions at any point during the procedure. Due to this, there were several points of missing data during the AUT baseline (first-grade: n=1 for “shoe”, n=2 for “chair”), AUT persistence (first-grade: n=3 for “shoe” and n=2 for “chair”) and AUT label (first-grade: n=1 for “bubble-wand” and “lightbulb”; fourth-grade: n=1 for “lightbulb”) where a participant chose to skip to the next item. All missing data was handled pairwise for fluency, flexibility and originality.

	Total			First-Grade			Fourth-Grade			Adult		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
Baseline												
Brick	182	5.52	2.63	41	3.83	1.97	41	5.83	3.22	100	6.09	2.32
Box	182	6.16	2.80	41	4.73	2.79	41	6.41	3.38	100	6.65	2.33
Shoe	181	5.41	2.71	40	3.78	1.95	41	5.80	2.69	100	5.90	2.74
Chair	180	5.95	2.66	39	4.38	2.10	41	5.71	2.91	100	6.66	2.48
Total	182	5.74	2.32	41	4.13	1.80	41	5.94	2.69	100	6.33	2.04
Persistence												
Brick	182	3.14	2.47	41	2.80	2.40	41	4.05	2.99	100	2.91	2.18
Box	182	3.24	2.48	41	2.27	1.55	41	4.37	3.44	100	3.17	2.13
Shoe	179	2.68	2.28	38	1.84	1.73	41	2.98	2.81	100	2.88	2.18
Chair	180	2.75	2.11	39	1.85	1.44	41	3.05	2.57	100	2.98	2.04
Total	182	2.94	1.95	41	2.16	1.24	41	3.61	2.59	100	2.99	1.78
Amb Label												
	90	4.82	2.79	21	3.81	2.58	20	4.35	3.36	49	5.45	2.50
Dinosaur												
Car	90	4.47	2.34	21	3.57	2.32	20	4.60	2.95	49	4.80	2.01
Bubble	89	4.22	2.67	20	3.15	2.50	20	4.10	3.31	49	4.71	2.35
Light	88	4.63	2.38	20	3.70	2.13	19	5.11	2.92	49	4.82	2.19
Total	90	4.50	2.33	21	3.48	2.20	20	4.49	2.99	49	4.94	1.97
NA Label												
	91	5.32	2.37	19	4.26	2.58	21	5.76	2.57	51	5.53	2.12
Dinosaur												
Car	91	5.30	2.41	19	4.53	2.44	21	6.19	2.14	51	5.22	2.43
Bubble	91	5.16	2.34	19	4.74	3.51	21	6.00	3.11	51	4.98	1.95
Light	91	4.91	2.42	19	4.32	3.09	21	5.67	2.54	51	4.82	2.03
Total	91	5.17	2.15	19	4.46	2.68	21	5.91	2.36	51	5.14	1.77

Table 1. AUT Descriptives. Baseline=AUT baseline; Persistence=AUT persistence; Label=AUT label. Box=Cardboard box; Bubble=bubble-wand; Light=lightbulb, Amb Label = Ambiguous label condition, NA Label = Non-Ambiguous Label Condition

Flexibility, or the number of categories used, was calculated for the AUT baseline, AUT persistence and AUT label. Responses were coded into a keyword or keyphrase to categorize similar answers (Dippo & Kudrowitz, 2013). For example, responses such as “build house” and “build school” were both given a category keyword of “build” for responses to “brick”, whereas “throw at someone” and “hit someone” were both given a category keyword of “weapon”. All keywords generated can be found in Appendix A. Keywords were generated by four separate researchers based on criteria outlined in Dippo and Kudrowitz (2013). Researchers first worked separately to generate keywords for each item then all researchers came together to ensure that agreement was met on which keyword/keyphrase each response belonged to. If a response had a two-part answer (e.g., “wash it and drink out of it”) the overall message was used to categorize the response (e.g., “drinking out of”) to ensure that the flexibility score was not inflated compared to the fluency score. Once each response for all items (e.g., brick, chair, etc…) had been given a category keyword/keyphrase the number of categories for each participant were added together to provide one flexibility score for each item on the AUT per participant. These scores were then totaled for each item on the AUT baseline (i.e., “brick”, “cardboard box”, “shoe” and “chair”), on the AUT persistence (i.e., the second set of responses to the same items as in AUT baseline), and on the AUT label (i.e., “dinosaur/pelganum”, “car/bup”, “bubble-wand/sharitnim”, and “light-bulb/blicket”) to be used as the dependent variables (Hocevar & Michael, 1979; Runco, 1986; Silvia, Winterstein, Willse, Barona, Cram, Hess, et al., 2008). Cronbach’s alpha measuring internal consistency for flexibility scores on the AUT baseline was .85, on the AUT persistence was .85, and on the AUT label was .87.

Originality, or the uniqueness of each response, was then coded by the primary researcher for each of the dependent variables. After providing each response with a category keyword, each keyword was entered alphabetically into a spreadsheet. Every individual response from each participant, across all age groups, was then entered under its corresponding category keyword to assess originality. Repeated responses between participants were only entered once and participant numbers were entered next to each response to calculate how many participants gave each response. For example, 62 participants across all age groups stated that you could “build a house” with a “brick”. Following divergent thinking coding scheme for originality by Hoicka, Bijvoet-van den Berg, Kerr & Carberry (2013), responses that were made by less than

5% of participants across all age groups received a score of “3”, responses by 6-20% of participants received a score of “2”, responses given by 21-50% of participants was given a score of “1” and responses made by over 50% of participants was given a score of “0”. Several answers were given that were merely a description of the item (e.g., “it’s black” or “it has edges”). These answers were given a score of “0” for originality since they did not list an actual use of the item across all age groups. Originality scores were averaged for one originality score for AUT baseline, AUT persistence and AUT label per participant. Cronbach’s alpha measuring internal consistency among originality scores for the AUT baseline was .51, for the AUT persistence was .44, and for the AUT label was .52.

Mindset Questionnaire. An 8-item questionnaire was used to assess individuals’ mindset (Dweck, 2006). The mindset questionnaire consisted of 4 items related to a fixed mindset (i.e., “you can always learn things, but you can’t really change how smart you are”) and 4 items to assess a growth mindset (i.e., “you can always change your talent a good amount, no matter how much you have”). Four items used a 6-point Likert scale ranging from 1 “disagree big time” to 6 “agree big time” and the other four items used a 6-point Likert scale ranging from 1 “agree big time” to 6 “disagree big time”. Adults completed the same questionnaire as children but used different Likert anchors ranging from 1 “disagree a lot” to 6 “agree a lot” in order to use more adult language. Internal reliability for the Mindset Questionnaire was 0.56. A total score was calculated for mindset by summing all responses together. Higher scores indicated more of a growth mindset and lower scores indicated more of a fixed mindset.

Wechsler Abbreviated Scales of Intelligence- Vocabulary (WASI-Vocabulary). During the AUT we examined whether the use of an ambiguous or non-ambiguous label would influence the creative output for children and adults. Since this study is verbal in nature through the use of labels and determining if EF contributed to creativity above and beyond language, the vocabulary section of the Wechsler Abbreviated Intelligence Scale (WASI; Ricketts, Nation & Bishop, 2007) was used to account for vocabulary ability. The WASI was created to use for adults and children ages six and up. Participants were instructed to state the meaning of a word after it was read aloud to them. The task was terminated after either three consecutive incorrect responses or reaching the maximum number of words; 28 words for adults, 22 words for children. For each item the participant was able to score either 2 points when demonstrating clear understanding of the word; 1 point when demonstrating vague understanding of the word; or 0 points if they did not know the word or provided an incorrect answer. A total raw score was used to assess vocabulary where higher scores indicated better vocabulary understanding.

III. RESULTS

Descriptive Statistics, Transformations, Outlier Analysis, and Missing Data

Descriptive statistics can be found in Table 2. There were two variables that were further subjected to transformations and outlier removal. The adult version of the DCCS produced negatively skewed data (skewness=-2.91 and kurtosis=9.27). Following guidelines from Tabachnick and Fidell (2007) and Howell (2007) a log transformation was conducted on the data with a reflective component (NEWvariable = log10(k-x) where k = constant from which a new score is subtracted so the smallest score is 1 which is usually equal to the largest score plus 1). This transformation of cognitive flexibility in adults is reported and used in analyses (new skewness= 0.80, kurtosis=.44). For AUT persistence, a difference score was calculated to determine whether participants overvalued, undervalued or correctly estimated their persistence on the AUT task. Box plot analyses indicated there were two positive outliers that fell above 2.194 (Q3 + 2.0 * interquartile range) and four negative outliers that fell below -2.043 (Q1 – 2.0 * interquartile range; Sheskin, 2004). These six cases were removed from analyses. Several tasks included missing data. The BDS had two cases of missing data for children who did not pass the training phase. The Mindset questionnaire, persistence, and the AUT creativity task each had four cases of missing data where children decided to stop testing before reaching the task. The WASI-Vocabulary task included four cases where children decided to stop the session before reaching the task and one case where a parent picked a child up early and the child was unable to complete the task to receive a total score. All missing data was handled pairwise.

	First Grade			Fourth Grade			Adult		
	N	Range	M(SD)	N	Range	M(SD)	N	Range	M(SD)
ge	42	5.22-8.84	7.13(.80)	41	8.66-12.01	9.96(.79)	100	18-22	19.05(.89)
Variables									
3DS	42	0-5	3.12(.97)	40	3-7	4.16(1.09)	100	3-9	5.60(1.10)
DCCS	42	3-12	7.74(.26)	41	5-12	9.47(2.22)	100	10-24	22.21(2.68)
DoG	42	0-9	6.52(2.71)	41	2-9	6.54(2.10)	100	0-9	5.46(2.28)
ocabulary	38	0-28	13.39(7.10)	40	6-37	23.58(7.06)	100	7-43	29.85(6.94)
ndset	40	8.00-43.00	23.78(8.87)	41	10.00-29.00	22.37(4.51)	98	15.00-33.00	24.43(3.86)
uency									
Baseline	41	.67-8.75	4.13(1.80)	41	1.00-12.75	5.94(2.69)	100	2.00-12.75	6.33(2.04)
Persistence	41	.00-4.75	2.16(1.24)	41	.00-10.50	3.61(2.59)	100	.00-8.50	2.99(1.78)
Label									
Ambig	21	.00-7.25	3.48(2.20)	20	.75-13.00	4.49(2.99)	49	2.25-12.50	4.94(1.97)
Non-Am	19	1.00-12.50	4.46(2.70)	21	2.75-11.25	5.90(2.36)	51	1.25-11.25	5.14(1.77)
xibility									
Baseline	41	.50-5.00	2.76(1.06)	41	1.00-7.50	4.07(1.60)	100	1.75-8.25	4.78(1.30)
Persistence	41	.00-3.75	1.68(.97)	41	.00-6.00	2.50(1.54)	100	.00-6.75	2.37(1.31)
Label									
Ambig	21	.00-5.00	2.58(1.35)	20	.75-9.50	3.26(2.05)	49	2.00-7.25	3.80(1.18)
Non-Am	21	1.00-5.50	2.88(1.35)	21	1.50-8.50	4.18(1.73)	51	1.25-7.50	3.79(1.25)
iginality									
Baseline	41	.00-2.31	1.49(.44)	41	.54-2.28	1.68(.41)	100	.63-2.39	1.56(.30)
Persistence	41	.00-3.00	1.72(.64)	41	.00-2.75	1.92(.64)	100	.00-6.58	1.90(.76)
Label									
Ambig	21	.00-2.66	1.79(.64)	20	1.00-2.75	1.92(.51)	49	1.39-2.55	2.02(.25)
Non-Am	19	.25-2.69	1.65(.70)	21	1.32-2.60	2.10(.33)	51	.75-2.44	1.91(.32)
rsistence	41	.00-16.00	3.80(4.18)	41	.00-62.00	6.78(10.42)	100	.00-49.00	6.71(7.21)

Table 2. Descriptive Statistics. BDS = Backward Digit Span (Working Memory), DCCS = Dimension Change Card Sort (Cognitive Flexibility), DoG = Delay of Gratification Task (Inhibition); Ambig = Ambiguous labeling condition, Non-Am = Non-ambiguous labeling condition.

There were low to moderate correlations between different components of EF, see Table 3A and 3B (e.g., Miyake et al., 2000). Only the BDS and DCCS were correlated in children, $r = .39$, $p < .001$ and DoG task and DCCS were negatively correlated in adults, $r = -.21$, $p = .03$. These results paired with the increasing divergence in later childhood (Lehto, Juujarvi, Kooistra & Pulkkinen, 2003) and my hypotheses of differential contributions to creativity (e.g., positive correlations with WM, measured by BDS, and cognitive flexibility, measured by DCCS, and negative correlations with inhibition, measured by DoG) led me to examine the three EF components separately in the analyses. Correlations between baseline creativity (i.e., fluency flexibility and originality) and age, mindset, WASI-Vocabulary, and EF performance in the BDS (i.e., WM), DCCS (i.e., cognitive flexibility) and DoG task (i.e., inhibition) are presented in table 3A and 3B and reveal a different relationship for children compared to for adults. For children, those who performed better on the BDS (i.e., higher working memory) showed better fluency and flexibility on the AUT, while those who performed better on the DCCS (i.e., better cognitive flexibility) had higher flexibility scores on the AUT. Age was also related to fluency, flexibility and originality on the AUT, such that children performed better on each as they age. However, for adults, those who performed well on the DCCS (i.e., higher cognitive flexibility) actually showed worse flexibility and originality on the AUT, while those who did well on the DoG task (i.e., better inhibition) performed better on flexibility on the AUT. Children and adults showed a similar trend in vocabulary and creativity. Children who performed better on the WASI-Vocabulary task performed better on fluency, flexibility and originality on the AUT. While adults who performed better on the WASI-Vocabulary task had higher scores on flexibility and originality on the AUT.

	1	2	3	4	5	6	7	8
1. Age								
2. BDS	.51**							
3. DCCS	.31**	.39**						
4. DoG	.02	-.09	-.05					
5. Mindset	-.01	-.18	.09	.03				
6. WASI-Vocabulary	.50**	.57**	.39**	-.04	-.21			
7. Fluency Baseline	.43**	.40**	.16	.01	-.08	.43**		
8. Flexibility Baseline	.51**	.47**	.27*	-.03	-.05	.57**	.87**	
9. Originality Baseline	.30**	.12	.03	.13	.19	.24*	.58**	.54**

Table 3A. Bivariate correlations for children BDS = Backward Digit Span (Working Memory), DCCS = Dimension Change Card Sort (Cognitive Flexibility), DoG = Delay of Gratification Task (Inhibition)

	1	2	3	4	5	6	7	8
1. Age								
2. BDS	.26**							
3. DCCS	-.05	.-.12						
4. DoG	.01	-.05	-.21*					
5. Mindset	-.01	-.08	.08	.04				
6. WASI-Vocabulary	.10	.04	-.21*	.23*	-.07			
7. Fluency Baseline	.02	-.02	-.13	.19	-.08	.19		
8. Flexibility Baseline	-.09	-.01	-.21*	.25*	-.01	.24*	.78**	
9. Originality Baseline	-.01	.05	-.23*	.14	.14	.25*	.70**	.73**

Table 3B. Bivariate correlations for adults. BDS = Backward Digit Span (Working Memory), DCCS = Dimension Change Card Sort (Cognitive Flexibility), DoG = Delay of Gratification Task (Inhibition)

Influence of Age on Baseline Divergent Thinking

A one-way ANOVA was used to test the first hypothesis that a significant slump in divergent thinking creativity would occur in fourth-graders while first-graders and adults would have higher divergent thinking creativity scores. This hypothesis was not supported as there was no significant fourth-grade slump, but rather divergent thinking scores appeared to increase with age, see Figures 3A-C. There was a significant effect of age on fluency at baseline, $F(2, 181) = 15.33$, $p < .001$, $\eta^2 = .15$. Tukey's post-hoc analyses revealed that fourth-graders showed better fluency than first-graders, $p = .001$ and adults showed better fluency than first-graders, $p < .001$, see Figure 3A. There was also a significant effect of age on flexibility at baseline, $F(2, 181) = 34.14$, $p < .001$, $\eta^2 = .28$. Again, Tukey's post-hoc analyses revealed that fourth-graders performed better than first-graders, $p < .001$, and adults performed better than first-graders, $p < .001$. Adults also performed better than fourth-graders, $p = .01$, see Figure 3B. Finally, a marginally significant effect of age was found on originality at baseline as well, $F(2, 181)$, =

2.76, $p = .07$, $\eta^2 = .03$. Originality at baseline appears to follow a u-shape pattern where fourth-graders marginally perform better than first-graders, $p = .06$. Fourth-graders also appear to perform better than adults, though this effect is not significant, $p = .19$, see Figure 3C.

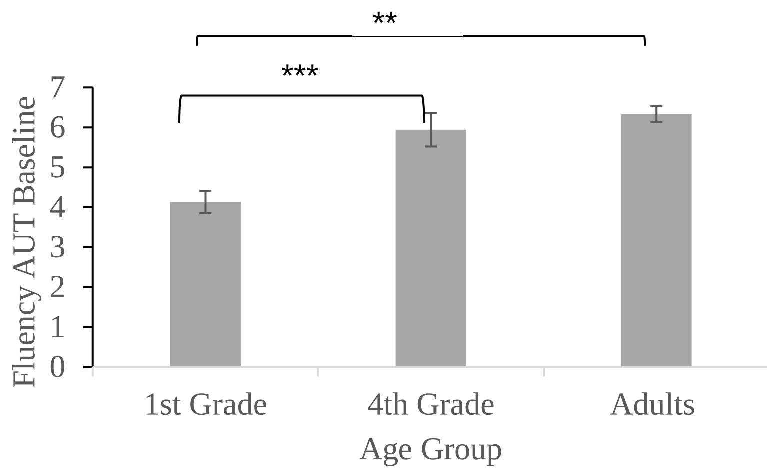

Figure 3A. Age and Fluency. Mean fluency on AUT baseline for first-graders, fourth-graders and adults. ***p*<.01, ****p*<.001.

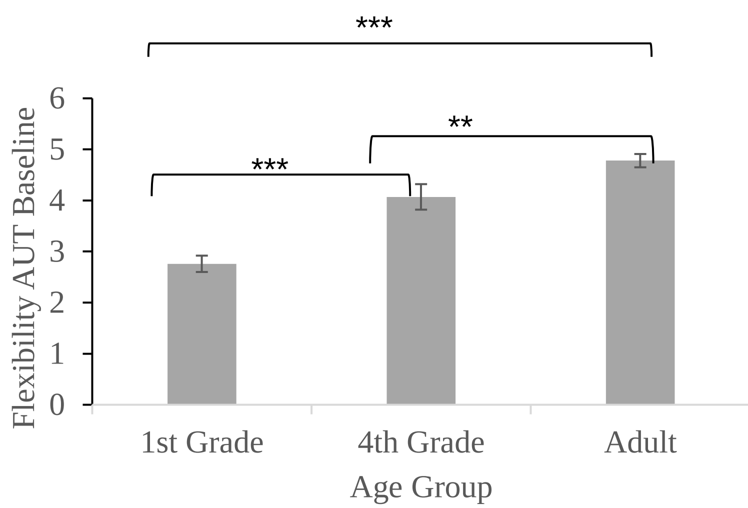

Figure 3B. Age and Flexibility. Mean flexibility scores on the AUT Baseline for first-grade, fourth-grade and adult. ***p*<.01, ****p*<.001.

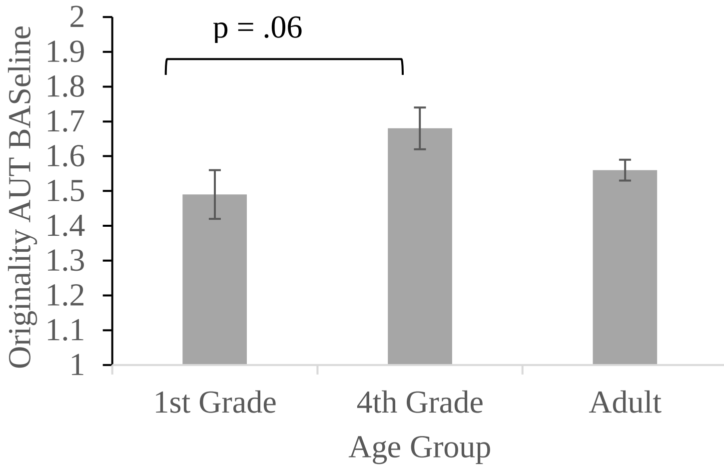

Figure 3C. Age and Originality. Mean originality scores on AUT baseline for first-graders, fourth-graders and adults. Results for originality were not significantly different across age groups.

Relative Contribution of Cognitive and Motivation Factors on Baseline Divergent Thinking

To examine the relative influence of EF and mindset on baseline creativity scores I ran a separate multivariate GLM for children (first-graders and fourth-graders) and adults with Divergent Thinking (DT) scores for fluency, flexibility and originality on the AUT entered as dependent variables and age (categorical for children, either first- or fourth-grade), the three EF variables (BDS, DCCS, and DoG task), mindset, and vocabulary as predictor variables[1].

---

[1] Analyses were also run with children and adults in the same analysis by calculating z-scores on the raw EF scores to account for the different measures (i.e., z-scores calculated for children and adults). A multivariate GLM with fluency, flexibility and originality on the AUT baseline as dependent variables and age, z-score for BDS, DCCS and DoG, vocabulary and mindset were entered as predictor variables. Interactions between age and EF, age and mindset and age and vocabulary were also explored. BDS was significantly related to DT, $F(1,171) = 3.64$, $p = .01$; *Wilk's* $\Lambda = .93$, *partial* $\eta 2 = .06$, where there was a marginally significant effect demonstrating that those with better working memory had better originality scores, $F(1,171) = 2.97$, $p = .09$. Vocabulary also was significantly related to DT, $F(1,171) = 3.66$, $p = .01$; *Wilk's* $\Lambda = .99$, *partial* $\eta 2 = .01$, where higher vocabulary related to higher fluency, $F(1,171) = 4.36$, $p = .04$, higher flexibility $F(1, 171) = 8.36$, $p = .004$, and higher originality, $F(1, 171) = 8.76$, $p = .004$. All other variables were not related to DT baseline scores and there were no significant age interactions, all $F's(1,171) < 3.34$, $p's > .07$, *Wilk's* $\Lambda > .92$, *partial* $\eta^2 > .01$. Since patterns of results were similar when adults and children were in the same analysis and we did not find evidenced of a 4th grade slump—which is why adults were

Interactions between age and EF, age and mindset and age and vocabulary were also explored. For children, only BDS was significantly related to DT scores $F(1, 73) = 2.88$, $p = .04$ *Wilk's Λ* = .87, *partial* $\eta^2 = .13$. Follow up analyses revealed a marginally significant effect of the BDS, with higher working memory performance on this task relating to greater originality in DT responses, $F(1,73) = 2.70$, $p = .09$. DT scores were not significantly related to DCCS (i.e., cognitive flexibility), $F(1, 73) = 0.32$, $p = .82$, *Wilk's Λ* = .99, *partial* $\eta^2 = .02$, or DoG (i.e., inhibition) $F(1, 73) = 0.10$, $p = .97$, *Wilk's Λ* = .99, *partial* $\eta^2 = .01$. Further, mindset was not related to DT scores, $F(1, 73) = 0.06$, $p = .98$, *Wilk's Λ* = .99, *partial* $\eta^2 = .01$, and vocabulary was marginally related to DT in children, $F(1, 73) = 2.39$, $p = .08$, *Wilk's Λ* = .89, *partial* $\eta^2 = .11$, where children who performed better on vocabulary had higher flexibility on the AUT, $F(1, 73) = 5.56$, $p = .02$, and higher originality on the AUT, $F(1, 73) = 4.61$, $p = .03$.

For adults, none of the individual difference variables related to DT scores. For EF, there were no significant relationships between DT scores and either BDS, $F(1, 97) = 1.70$, $p = .18$, *Wilk's Λ* = .94, *partial* $\eta^2 = .06$, DCCS, $F(1, 97) = 0.86$, $p = .47$, *Wilk's Λ* = .97, *partial* $\eta^2 = .03$, or DoG, $F(1, 97) = 1.37$, $p = .26$, *Wilk's Λ* = .95, *partial* $\eta^2 = .05$. Further, there was also no relationship between mindset and DT, $F(1, 97) = 0.63$, $p = .60$, *Wilk's Λ* = .98, *partial* $\eta^2 = .02$, or vocabulary and DT, $F(1, 97) = .65$, $p = .59$, *Wilk's Λ* = .98, *partial* $\eta^2 = .02$.

---

included in the first place, I presented adults and children in separate analyses so that I could better examine how raw scores in the slightly different EF measures given at each age related to creativity for children and adults.

Contribution of Labeling and EF to Divergent Thinking

A multivariate general linear model with fluency, flexibility and originality for the AUT Label entered as dependent variables and age group (categorical: first-grade, fourth-grade and adult) and condition (ambiguous or non-ambiguous label) as predictors was conducted to test whether there was a relationship between labeling condition and DT. An age by condition interaction was also explored. There was a significant main effect of labeling, $F(1, 180) = 4.35$, $p = .006$; *Wilk's Λ* = .93, *partial* $\eta^2 = .07$, demonstrating an influence of labels on DT in the opposite direction than predicted. Specifically, those in the non-ambiguous condition had higher fluency generating significantly more ideas than those in the ambiguous condition $F(1,180) = 5.84$, $p = .02$, see Figure 4. A main effect of age group was also found, $F(1,180) = 4.74$, $p < .001$, *Wilk's Λ* = .85, *partial* $\eta^2 = .08$. Tukey's post-hoc analysis demonstrated a significant difference between first- and fourth-graders and between first-graders and adults, *p*'s < .03, but no difference between fourth-graders and adults, *p*'s > .90 on fluency, flexibility and originality, again demonstrating a lack of a fourth-grade slump. There was no significant interaction between age and labeling condition on DT scores, $F(1,180) = 1.23$, $p = .296$, *Wilk's Λ* = .96, *partial* $\eta^2 = .02$, suggesting that that fourth graders did not benefit more from the ambiguous label and instead all ages benefited from the non-ambiguous label equally.

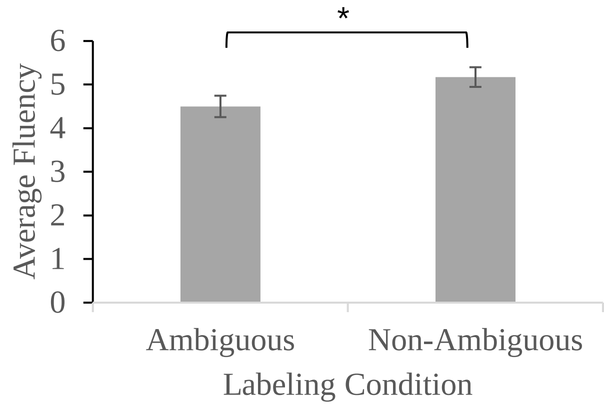

Figure 4. Fluency and Labeling Condition. Those in the non-ambiguous condition generated more responses (higher fluency) on the AUT than those in the ambiguous condition. *$p < .05$.

I ran two separate multivariate GLM's, one for children and one for adults, to test whether higher EF would help DT scores particularly in the ambiguous condition[2]. For children, fluency, flexibility and originality on the AUT Label were entered as dependent variables with age category (first-grade or fourth-grade), condition, and the three EF variables, BDS, DCCS, and DoG task as predictors. Two-way interactions of age by condition and EF by condition were explored along with three-way interactions between age, EF and condition. For children, main effects were not found for age, condition, DCCS or DoG task, all $F's(1,79) < 1.04$, $p's > .38$, $Wilk's\ \Lambda > .89$, $partial\ \eta^2 > .01$. There was a marginal effect for BDS, $F(1,79) = 2.52$, $p = .06$,

---

[2] Analyses were also run using all age groups and z-scores for the EF variables as was done for baseline creativity scores. The results mirrored the ones found when examining children and adults separately with neither working memory, F (1,179) = .1.63, $p = .18$; $Wilk's\ \Lambda = .97$, $partial\ \eta^2 = .03$, cognitive flexibility, F (1,179) = .29, $p = .83$; $Wilk's\ \Lambda = .10$, $partial\ \eta^2 = .01$, nor inhibition, F (1,179) = .90, $p = .44$; $Wilk's\ \Lambda = .98$, $partial\ \eta^2 = .02$, were related to DT in this model. Interactions between labeling condition and age, and condition by EF were not significant. There were also no significant age interactions, all p's > .17. Again, given the lack of age interactions I decided to run adults and children in separate analyses so that I could better examine how raw scores in the different EF measures given at each age related to creativity for children and adults.

Wilk's Λ = .96, *partial* η^2 = .11, where children with higher scores on the BDS (i.e., better working memory) had better originality on the AUT, $F(1,79) = 5.48$, $p = .02$, and marginally better flexibility on the AUT, $F(1,79) = 3.66$, $p = .06$. An age by condition interaction was not significant, $F(1,79) = .98$, $p = .76$, *Wilk's Λ* = .98, *partial* η^2 = .02. Condition by any EF variable interactions were also not significant, all *F's*(1,79) < 1.06, *p's* > .37, *Wilk's Λ > .95, partial* η^2 > .04. Three-way interactions between age, all three EF variables and labeling condition were also not significant, all *F's*(1,79) < 1.67, *p's* > .13, *Wilk's Λ > .85, partial* η^2 > .02.

In the GLM for adults, I entered fluency, flexibility and originality on the AUT Label as dependent variables with condition, and the three EF variables, BDS, DCCS, and DoG task, as predictors. Two-way interactions of condition and EF variables were explored. Main effects were not found for condition, or for any of the EF variables, all *F's*(1,97) < 1.03, *p's* > .38, *Wilk's Λ > .97, partial* η^2 > .001. Interactions between condition and all EF variables were not significant, all *F's*(1,97) < 2.40, *p's* > .19, *Wilk's Λ > .98, partial* η^2 > .02. Three-way interactions between age, all three EF variables and labeling condition were also not significant, all *F's*(1,79) < 1.92, *p's* > .09, *Wilk's Λ > .97, partial* η^2 > .02.

Persistence, Mindset and Divergent Thinking

Difference scores were calculated for the dependent variable of fluency on the AUT after being asked to persist, where the actual total number of responses generated by the participant during their second attempt at answering was subtracted from the number of items the participant expected to generate. Higher scores indicated that a participant overvalued their persistence (i.e., expected to generate more responses than they actually did when given the opportunity to persist), lower scores indicate that they undervalued their persistence (i.e., expected to generate fewer responses than they actually did) and a score of zero indicated that the participant correctly estimated how many responses they would generate when given more time. Only fluency was used to calculate this dependent variable since persistence relates more to the number of ideas one can generate than it does to either the number of categories (flexibility) or how unique their responses would be (originality). The difference score was entered as the dependent variable with age (categorical either first-grade, fourth-grade or adult), mindset and an age by mindset interaction entered as predictors in the model.

A univariate GLM was used to examine whether adults and children show different patterns in their value of persistence and whether individuals with a growth mindset would be less likely to undervalue their persistence. Difference scores for persistence were entered as the dependent variable with age category and mindset entered as independent variables. An age by mindset interaction was also explored. There was no main effect for age, $F(2,172) = 1.50$, $p = .23$, suggesting that there was no difference in how children and adults valued persistence in a divergent thinking task . There was also no main effect for mindset, $F(1,172) = .59$, $p = .45$, suggesting that there was no difference for those with a growth or fixed mindset on the value of persistence in a divergent thinking task. An age by mindset interaction was also not significant, $F(2,172) = 2.08$, $p = .13$, which also failed to provide evidence for differences in how children and adults with a growth mindset versus a fixed mindset value their persistence on a divergent thinking task. Since age was not a significant predictor of value of persistence, I conducted a one sample t-test to determine whether people across all age groups undervalued, overvalued, or correctly estimated their persistence on the AUT. Across all age groups, people tend to undervalue their persistence, $t(181) = 10.78$, $p < .001$. Specifically, people estimate on average they will produce about one and a half more responses (*M* = 1.52, *SD* = 1.90) and actually produce approximately three more responses (*M* = 2.94, *SD* = 1.95) when given more time, see Figure 5.

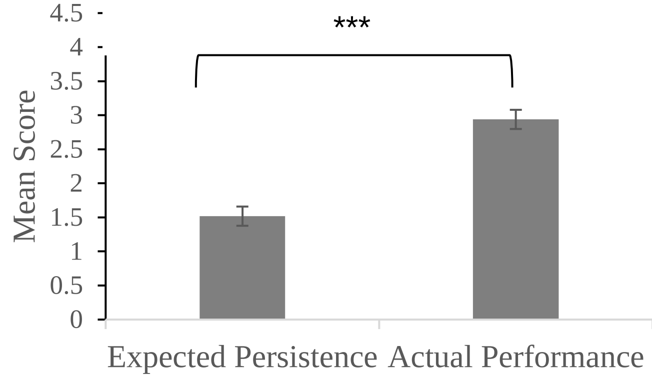

Figure 5. Persistence and Creativity. Mean scores for expected performance (i.e., number of items participants believed they would generate) compared to actual performance (i.e., number of items they actually generated when given more time). ***$p < .001$.

IV. DISCUSSION

The current study aimed to confirm a significant slump in creativity around fourth-grade and examine whether EF, labeling and mindset contributed to creativity across the lifespan. A slump in creativity was not found, rather, divergent thinking creativity scores tended to increase from first-grade to adulthood. In the present study, EF was more strongly related to creativity for children than for adults. Better EF and vocabulary were related to higher creativity scores for children, and when considered together, working memory emerged as the strongest predictor of originality. This same trend did not occur for adults, where EF was not a significant predictor of creativity and though vocabulary was positively correlated with flexibility and originality in adults, it was not a successful concurrent predictor of creative ability when considered together with other factors. When examining whether using an ambiguous label would aid in creativity over using a non-ambiguous label, surprisingly the use of the non-ambiguous label was more beneficial to fluency for all ages. Finally, growth mindset did not lead to more divergent thinking creativity scores in either children or adults. All age groups undervalued their persistence on a divergent thinking creativity task and this was not related to their mindset. The results of this study demonstrate that creativity increases as individuals age and is influenced by the type of label used during a creative task (i.e., non-ambiguous label), persistence (i.e., although people tend to undervalue persistence in a creative task, persistence does generally lead to more creative responses), and EF (i.e., working memory aids in better originality for children, but not for adults).

Development of Creativity

Contrary to prior reports speculating a slump in creativity in the fourth-grade (Torrance, 1967; 1968), in the present study fluency and flexibility in creativity increased with age from first-grade to fourth-grade until adulthood. There are several possible reasons for these linear creativity increases with age. First, these findings are consistent with research showing that relative “slumps” and “peaks” in creativity show inconsistency across research as to what age they occur (Barbot, Lubart & Besancon, 2016; Charles & Runco, 2001; Kim, 2011). For example, Charles and Runco (2001) found a peak in creativity at fourth-grade rather than a slump, and Kim (2011) and Lau and Cheung (2010) did not find a fourth-grade slump, but rather slumps in sixth- or seventh-grade. Though the current study found a linear relationship demonstrating creativity improves with age, I only examined creativity in first-grade, fourth-grade and adulthood, limiting the ability to detect slumps in creativity in other age groups. Thus, it is possible that a significant slump in creativity may exist at another age group (e.g., a slump existing in the sixth-grade, Kim, 2011).

Second, the different tasks used in studies about the development of creativity may explain the variations in the timing of slumps (Barbot, Lubart & Besancon, 2016). Though I used the most widely used measure of creativity in the literature, the AUT (a portion of the Torrance Test of Creative Thinking which were used to establish the fourth-grade slump; Torrance, 1968), studies examining the development of creativity have utilized other measures. For example, Claxton, Pannels and Rhoads (2005) who found a slight increase in DT scores from fourth- to ninth- grade utilized the Creativity Assessment Packet for measures of divergent thinking and divergent feeling; a peak in fourth-grade found by Charles and Runco (2001) used the two instances task where participants were asked to name instances of round things and things that make noise; and Kim (2011) used the Torrance Test of Creative Thinking to find a slump in sixth-grade. Several studies that have administered multiple creativity tasks have outlined different developmental trajectories for each task (Barbot, Lubart & Besancon, 2016; Claxton et al., 2005; Torrance, 1968), demonstrating that the specific task used may measure creative potential in slightly different ways.

These differences between tasks are likely due to each task targeting a specific facet of creativity (i.e., divergent thinking: many solutions to a single problem such as the uses for a brick, or convergent thinking: one solution to a problem such as finding a way to make a pendulum swing using only one item) while creativity is more than just the sum of its parts and needs to be considered as a whole where convergent and divergent thinking work together . My finding of a linear increase in creativity when using the AUT adds to the developmental creativity literature and suggests that creativity might increase as people age rather than be marked by specific slumps throughout development. However, the fact that patterns of creativity are so variable and depend heavily on the type of task used suggests that more work is needed in this area. Using different measures of creativity that include both divergent and convergent thinking within creativity to assess its development could influence the variations in timings for slumps as the deficits found may be related to each specific task more than to age. Utilizing multiple measures of creativity using different facets of creativity would allow research on its development to determine whether trends in development (i.e, slumps in creativity) are relegated to individual facets of creativity and help parse out the trajectory of its development more completely.

Contribution of EF and Vocabulary to Divergent Thinking

Another novel finding in this study was related to a possible differential relationship between EF and creativity in children and adults. Better working memory was associated with better fluency and flexibility on the AUT in children and better cognitive flexibility was associated with better flexibility on the AUT in children. When examined together, working memory was shown to be the strongest predictor of performance on the AUT with better working memory leading to higher scores for originality on the AUT at baseline and marginally higher scores for originality and flexibility during the labeling condition. These results support previous research with adults where both cognitive flexibility (Beaty, Kennett, Christensen, Rosenberg, Benedek, Chen, et al., 2018; Zabelina & Robinson, 2010) and working memory (Asiz-Zadeh, Liew, & Dandekar, 2013) are shown to aid in creativity. Better cognitive flexibility is thought to contribute to creativity by allowing individuals to more easily switch between different techniques that may or may not be working during a problem-solving task (Zabelina & Robinson, 2010). The current research extends this finding to children showing that children who have higher cognitive flexibility perform better on flexibility on the AUT perhaps due to a greater ability to switch between their ideas during the divergent thinking task. Working memory, however, appeared to be the strongest predictor of performance on the AUT for children. This may be due to children having similar ability to adults in being able to mentally manipulate objects and potential uses for that object necessary for the task (Aziz-Zadeh, Liew, & Dandekar, 2013).

However, for adults, EF was not related to divergent thinking creativity either at baseline or in any labeling condition. These results also appear to be in contrast to previous literature demonstrating a link between EF and creativity in adults where higher cognitive flexibility was found among creative individuals (Beaty, Kennett, Christensen, Rosenberg, Benedek, Chen, et al., 2018; Zabelina & Robinson, 2010), a link between divergent thinking and working memory locations was found in the prefrontal cortex (Aziz-Zadeh, Liew, & Dandekar, 2013) and lower inhibition among was found creative individuals (Carson, Peterson, & Higgins, 2003; White & Shah, 2006). The lack of a EF-creativity link in adults could be more methodological in the present study. The tasks used to measure EF in adults and in children in the current study were designed to be as comparable as possible, but also slightly different from one another to make the tasks more age appropriate (e.g., the delay of gratification task to assess inhibition using stickers, pennies and erasers for children and using a hypothetical scenario about money for adults). This may have resulted in EF measures that were too simplistic for our adult sample. In current adult EF work the ecological validity of EF tests has been called into question. In one study by Chaytor, Schmitter-Edgecombe and Burr (2006), current most utilized EF tests such as the Stroop Test and Wisconsin Card Sorting Task only accounted for 18-20 percent of the variance in everyday executive functioning abilities. When environmental factors were added (e.g., environmental cognitive load) more of the variance was accounted for suggesting that there may be other influences on EF ability than the EF tasks can account for alone. Therefore, it is possible that the EF tests for adults in the current study were not inclusive enough to capture everyday EF ability in adults leading to the insignificant results.

Even with attempts to make these tasks more age appropriate, adults in the current study appeared to reach ceiling on the cognitive flexibility task (e.g., correctly answering all 24 items on the switch trials of the DCCS) even with using a measure of the DCCS designed for adults. Though our data was log transformed to account for these ceiling effects it may have contributed to the differences we see in children and adults. Using reaction times or a measure of cognitive flexibility that has been shown to not produce high ceiling effects would be beneficial in affirming these results.

The current study also examined how vocabulary was related to divergent thinking since the AUT is inherently a verbal task. Better vocabulary ability was positively related to fluency, flexibility and originality at baseline for children and to flexibility and originality at baseline for adults. These findings are in support of previous research that has found using mnemonics in an English as Second Language class has helped increase students' vocabulary and in turn their creativity on writing assignments (Pillai, 2017). The AUT requires that people think about specific uses for an object. Having a better vocabulary relates to this ability in that both children and adults can find a wider variety of uses for an object (e.g., higher flexibility) when they have a greater understanding of different types of words and concepts to begin with (e.g., higher vocabulary). Indeed, higher vocabulary has been linked with better strategies used during convergent problem-solving tasks (Blanchard-Fields, Chen, & Norris, 1997). The current results add to the literature by demonstrating that this link between higher vocabulary and better problem-solving extends into divergent problem-solving tasks such as the AUT for creativity measurement.

Contribution of Labeling to Divergent Thinking

Using labels in a functional fixedness task has been shown to influence performance on a divergent thinking creativity task (Glucksberg & Weisberg, 1966). The current study hypothesized that using an ambiguous label would further help individuals on a divergent thinking creativity task as opposed to using a non-ambiguous label because an ambiguous label would not anchor participants into a functional fixedness problem by responding with only the most common uses for an object (e.g., building a house for the word “brick”). However, using an ambiguous label for an object did not help participants think more creatively about uses for that object. In fact, using a non-ambiguous label actually helped participants generate more creative uses for an item. It is possible that people of all ages needed to be grounded in some concept of what an object is in order to determine what it might be useful for. When examining referential communication in children, Glucksberg, Krauss and Weisberg (1966) used a novel nomenclature for novel objects to determine whether 3-5- year old children could form representations of novel words for objects to communicate with others. A child and an experimenter were placed together to construct a tower of blocks with unfamiliar objects on them. The adult had to communicate with the child using novel nomenclature for these novel objects so that the child could construct an identical tower of blocks. In practice trials, children were able to represent the blocks and share nomenclature for familiar objects of animal faces on the blocks. However, during the testing phase with novel objects on the blocks, children performed much worse. The study found that unlike adults, children were unable to form solid representations of the shared nomenclature for the novel objects. This might suggest that using ambiguous labels of objects, similar to using novel nomenclature for objects, may be difficult for young children without some form of reference, or non-ambiguous label, to help guide them.

Related, work has found that ill-formed representations hinder problem-solving performance in preschoolers. For example, Miller, Marcovitch, Boseovski and Lewkowicz (2015) showed that when you provide preschool children with an unfamiliar label (e.g., an ordinal label of first, second and third, before they know what those concepts mean) it actually hinders their performance in a spatial search task. The authors suggest the decrease in performance may be due to the fact that they are establishing an ill-formed representation which hurts their performance when reflected on to guide behavior. Results from the current study may extend these findings and suggest that these types of ill-formed representations likely impact problem-solving in a creative divergent thinking task because children have difficulty forming a representation of the object presented to them when given an ambiguous label that does not ground the object in something familiar.

The fact that people perform better with a concrete non-ambiguous label aligns with other work demonstrating a benefit of concrete labels in convergent tasks as well. When both children and adults use verbal labels to represent what to do in a specific task, they can overcome difficulties on that task (Muller, Zelazo, Hood, Leone & Rohrer, 2004). For example, using a verbal label helps adults in the classic Stroop test where participants must name the color of ink with mismatching or matching color words (MacLeod, 1991). Stating the condition out loud (e.g., naming the color of the ink) before responding significantly improved performance for adults. Similarly, 3-year old children who used a verbal label before of task condition before responding to a task with a congruent trial (e.g., choosing two cards with the same object on them) and an incongruent trial (e.g., selecting two cards with different objects on them) significantly improved their ability to select the correct situation compared to 3-year old children who did not verbally label the situation before making a selection (Muller, Zelazo, Hood, Leone & Rohrer, 2004). Perhaps, using a non-ambiguous label aids in object representation similar to how a verbal label aids in task representation (MacLeod, 1991; Muller, Zelazo, Hood, Leone & Rohrer, 2004). That is for both children and adults using a familiar word label (non-ambiguous label) helps to form a representation of the object allowing for more creative responses for the object on the AUT. However, in the present study it is not clear whether the ambiguous label is hurting performance, the concrete label is helping performance, or whether there is a little bit of both occurring. Future studies should include a condition without labels to better understand how language influences our thinking during divergent thinking creativity tasks.

Estimation of Persistence on Divergent Thinking Task

Persistence allows individuals to push through difficult tasks and thinking creatively is often difficult and time consuming. Thus, having a strong belief that persistence will help you solve creativity tasks is important. However, Lucas and Nordgren (2015) found that adults undervalued persistence in a creativity task even though persisting often led to more ideas and more creative ideas. The current study extended these findings to children demonstrating that as young as first-grade, individuals will begin to undervalue persistence in a creative task. This appears in contrast to past research showing that children tend to overestimate their abilities (Butler, 1990). However, past research indicates that children overestimate their abilities when comparing themselves to others and the current study examines estimation of persistence only in relation to oneself. Although there are several possibilities for why children estimate their abilities differently when comparing themselves to others and to themselves, the Social Cognitive Career Theory (SCCT; Brown, Tramayne, Hoxha, Telander & Fan, 2008; Lent, Brown & Hackett, 1994) may shed light on why people of all ages are underestimating their level of persistence on creativity tasks. In this theory, students who perform well academically do so based on their ability to form concrete goals based on expectations of an outcome and self-efficacy beliefs that are derived from past performance (e.g., high school GPA) and general cognitive ability (e.g., SAT or ACT scores). Applied to creativity, it is possible that people are experiencing poor self-efficacy beliefs and deriving poor outcome expectations (i.e., underestimating their persistence on a creative task) due to prior performance on creative tasks (e.g., having to write a story in class). If people are exposed to creative tasks that do not match their creative ability, such as being forced to write a story in class when their creative ability is more apt for taking photographs, they may develop a sense of poor self-efficacy beliefs that lead them to lower estimation of how much persistence will help.

I believe this mismatch between creative tasks and creative ability starts young when children are exposed to creative tasks in school and this experience continues throughout the lifespan as shown in the results of the current study. For example, research on different pedagogical modalities focusing on either alternative pedagogy that focuses on things such as creativity (e.g., Montessori schools) or more traditional education techniques found in a typical public school have shown repeatedly that when focused on creative pedagogy children's creative achievement is improved (Avanzini & Ferrero, 1967; Besancon & Lubart, 2008; Frankieweicz, 1984) demonstrating that if children find a match to their creative potential they may increase their creative ability. Though this research only demonstrates creative ability being improved and not creative self-concept or persistence in creativity, if we examined persistence in creative tasks in an alternative pedagogical environment like a Montessori school versus a more traditional pedagogical environment differences might emerge.

Mindset and Divergent Thinking

When examining how motivational factors such as mindset, related to divergent thinking it was found that mindset was not related to divergent thinking creativity in either adults or children nor was it related to persistence. These results are surprising, as a growth mindset has been shown to benefit creativity and positively influence creative self-concepts (Bowden & Beeman, 1998; Karwowski, 2014; O'Neill, 2011). One possibility for the null relationship between mindset and divergent thinking may relate to the measure of mindset in the present study. The mindset questionnaire I used was a short eight-item questionnaire generally used to determine a general growth or fixed mindset that can be used for determining mindset related to anything, such as mindset about math or about IQ or about life in general (Dweck, 2006). Though using a questionnaire that could capture mindset in a wider variety of areas was the initial draw of using the mindset questionnaire, it is possible that using a different questionnaire that was longer and more appropriate for mindset more specifically related to creativity could have yielded different results. Specifically, researchers have typically studied growth and fixed mindsets as a singular term with the two operating at dual ends of a continuum (O'Connor, Nemeth & Akutsu, 2013). However, Karwowski (2014) used factor analysis and demonstrated people may hold different mindsets at the same time for different things. For example, a person may hold a fixed mindset related to solving math problems and a growth mindset related to solving divergent thinking creativity problems. Our measure treated mindset as a global ability, where someone held either a growth or fixed mindset that would be applied to every domain. Utilizing a mindset measure specific to divergent thinking in future studies would more accurately demonstrate whether a growth mindset is related to divergent thinking creativity by capturing how people view their mindset related specifically to creativity.

Another issue with the mindset questionnaire employed in the present study was its fairly low internal reliability scores. Though this scale has been used in previous studies and found to have higher reliability than in the current study (Dweck, 2006), this study may have found lower internal reliability due to combining children and adults in the same study. Dweck (2006) utilized this questionnaire in multiple studies, but all were conducted with adults finding higher internal reliability. When examining the internal reliability of the scale in the current sample with only adults it was found to be higher (i.e., $\alpha = .67$ as opposed to .56 when children and adults were included together) and reliability was relatively lower for children (i.e., $\alpha = .47$). This demonstrates that in our sample the lower reliability score for children may have caused the reliability for the mindset questionnaire to be lower than in previous studies limiting our interpretations of its results. This lower reliability for children may be due to children as young as first- or fourth-grade may not fully comprehend what the measure is trying to capture. When utilizing a different mindset measure that examines creativity mindset specifically as mentioned above, it will be important to use such a measure that is also specifically designed for children to ensure that all children are understanding the nature of the questions.

Conclusion

The current study contributes our understanding of creativity development in several important ways. First, it reiterates the unpredictability of the development of creativity showing a linear growth in creative ability from first-grade to adulthood. Second, it shows that cognitive factors like EF differentially contribute to creativity depending on age. For children in first- and fourth-grade, working memory played a significant role in originality of creative ideas. For adults, EF did not play a role in creative ability. Third, it demonstrates that non-ambiguous labels are more effective than ambiguous labels in aiding creative output. Fourth, personality factors such as mindset may not play a role in creativity. Lastly, all age groups tend to undervalue persisting through creative tasks. Though this study makes important contributions to the field, there are some limitations that need to be addressed. First, the study only used one divergent thinking creativity task, the AUT. Though the AUT is the most widely used divergent thinking creativity task, it is possible that task characteristics may have contributed to some of our null findings and using at least one other task could have addressed this. Second, it was found that non-ambiguous labels aided in creativity more than did ambiguous labels, but more research is needed to uncover why this phenomenon occurs. Third, our low internal reliability and continuous measure for mindset may have limited the observance of a relationship between mindset and creativity. Using a measure related to creative mindsets would help future studies better parse out this relationship or demonstrate that indeed no relationship exists as was found in this study. Lastly, though I examined how people evaluated persisting in a creative task, I did not examine possible reasons for this undervaluation. Future studies should examine the components of the SCCT in terms of creativity to determine how self-efficacy beliefs and ideas about past performance/ability may influence people's perceptions on whether persisting through a difficult creative task can be beneficial. Taken together, the results of this study demonstrate the complexity of creativity and its development from first-grade to adulthood.

REFERENCES

Adamson, R.E. (1952). Functional fixedness as related to problem solving: A repetition of three experiments. *Journal of Experimental Psychology, 44*(4), 288-291.0

Albert, R.S., & Runco, M.A. (1999). A history of research on creativity. In R.J. Sternberg (Ed.), *Handbook of creativity* (pp. 16-34). New York, NY: Cambridge University Press.

Amabile, T.M. (1985). Motivation and creativity: Effects of motivational orientation on creative writers. *Journal of Personality and Social Psychology, 48*(2) 393-399. doi: 10.1037/0022-3514.48.2.393.

Avanzini, G., & Ferrero, M. (1967). Contribution a une comparison entre les techniques Freinet et les methodes traditionalles d'enseigement [A comparison between Freinet and traditional teaching methods]. *Bulletin De Psychologie*, *30*(10-13), 455-467.

Aziz-Zadeh, L., Liew, S.L., & Dandekar, F. (2013). Exploring the neural correlates of visual creativity. *Social Cognitive and Affective Neuroscience, 8*(4), 475-480.. doi: 10.1093/scan/nss021.

Barbot, B., Lubart, T.I., & Besancon, M. (2016). "Peaks, slumps, and bumps": Individual differences in the development of creativity in children and adolescents. In B.B. Barbot (Ed.) *Perspectives on creativity development. New Directions for Child and Adolescent Development*, *151*, 33-45.

Beaty, R.E., Kenett, Y.N., Christensen, A.P., Rosenberg, M.D., Benedek, M., Chen, Q., Fink, A., Qiu, J., Kwapil, T.R., Kane, M.J., & Silvia, P.J. (2018). Robust prediction of individual creative ability from brain functional connectivity. *Proceedings of the National Academy* *of Sciences of the United States of America, 115*(5), 1087-1092. doi: 10.1073/pnas.1713532115.

Besancon, M., & Lubart, T. (2008). Differences in the development of creative competencies in children schooled in diverse learning environments. *Learning and Individual Differences, 18*(1), 381-389. Doi: 10.1016/j.lindif.2007.11.009.

Bijvoet-van den Berg, S., & Hoicka, E. (2014). Individual differences and age-related changes in divergent thinking in toddlers and preschoolers. *Developmental Psychology*, *50*(6), 1629-1639. doi: 10.1037/a0036131.

Blanchard-Fields, F., Chen, Y., & Norris, L. (1997). Everyday problem solving across the adult life span: Influence of domain specificity and cognitive appraisal. *Psychology and Aging, 12*(4), 684-693. doi: 10.1037/0882-7974.12.4.684.

Bowden, E.M., & Beeman, M.J. (1998). Getting the right idea: Semantic activation in the right hemisphere may help solve insight problems. *Psychological Science*, *9*(6), 435-440. doi: 10.1111/1467-9280.00082.

Brown, S.D., Tramayne, S., Hoxha, D., Telander, K., Fan, X., & Lent, R.W. (2008*).* Social cognitive predictors of college student's academic performance and persistence: A meta-analytic path analysis. *Journal of Vocational Behavior, 72*(3), 298-308. doi: 10.1016/j.jvb.2007.09.003.

Butler, R. (1990). The effects of mastery and competitive conditions on self-assessment at different ages. *Child Development*, *61*(1), 201-210. doi: 10.1111/j.1467-8624.1990.tb02772.x.

Carlson, S. M., Moses, L. J., & Brenton, C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development, 11,* 73-92. DOI:10.1002/icd.298.

Carlson, S.M., & Moses, L.J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development*, *72*(4), 1032-1053.

Carlson, S.M., Moses, L.J., & Claxton, L.J. (2004). Individual differences in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology, 87*, 299-319. doi:10.1016/j.jecp.2004.01.002

Carson, S.H., Peterson, J.B., & Higgins, D.M. (2003). Decreased latent inhibition is associated with increased creative achievement in high-functioning individuals. *Personality Processes and Individual Differences,* 85(3), 499-506. doi: 10.1037/0022-3514.85.3.499.

Charles, R.E., & Runco, M.A. (2001). Developmental trends in the evaluative and divergent thinking of children. *Creativity Research Journal*, *13*(3), 417-437.

Chaytor, N., Schmitter-Edgecombe, M., & Burr, R. (2006). Improving the ecological validity of executive functioning assessment. *Archives of Clinical Neuropsychology, 21*(1), 217-227. doi: 10.1016/j.acn.2005.12.002.

Claxton, A.F., Pannells, T.C., & Rhoads, P.A. (2005). Developmental trends in the creativity of school-age children. *Creativity Research Journal*, *17*(4), 327-335. DOI: 10.1207/s15326934crj1704_4.

Cropley, A. (2006). In praise of convergent thinking. *Creativity Research Journal, 18*(3), 391-404. doi: 10.1207/s15326934crj1803.13.

Dahlman, S. Backstrom, P., Bohlin, G., & Frans, O. (2013). Cognitive abilities of street children: Low-SES Bolivian boys with and without experience of living in the street. *Child Neuropsychology*, *19*(5), 540-556.

Damian, R.I. & Simonton, D.K. (2015). Psychopathology, adversity, and creativity: Diversifying experiences in the development of eminent African-Americans. *Journal of Personality and Social Psychology*, *108*(4), 623-636. doi: 10.1037/pspi0000011.

Dippo, C. & Kudrowitz, B. (2013). Evaluating the alternative uses test of creativity. *2013 National Conference on Undergraduate Research*.

Dweck, C.S. (2006). *Mindset: The new psychology of success.* New York, NY: Random House.

Dweck, C.S. (2007). The perils and promises of praise. In K. Ryan and J.M. Cooper (Eds.). *Kaleidoscope: Contemporary and classic readings in education.* Belmont, CA: Wadsworth.

Frankiewicz, W. (1984). Etude de l'influence de la technique du texte libre sur le développement de la pensée créative des enfants [Study of the effect of the free-text technique on development of creative thought in children]. *Scientia Paedagogica Experimentalis, 21*(2), 200–210.

Fuster, J.M. (2001). The prefrontal cortex-an update: Time is of the essence. *Neuron, 30*, 319-333.

German, T.P., & Defeyter, M.A. (2000). Immunity to functional fixedness in young children. *Psychonomic Bulletin & Review, 7*(4), 707-712.

Glucksberg, S., & Weisberg, R.W. (1966). Verbal behavior and problem solving: Some effects of labeling in a functional fixedness problem. *Journal of Experimental Psychology, 71*(5), 659-664.

Glucksberg, S., Krauss, R.M., & Weisberg, R. (1966). Referential communication in nursey school children: Method and some preliminary findings. *Journal of Experimental Child Psychology, 3*(4), 333-342. doi: 10.1016/0022-0965(66)90077-4.

Guilford, J.P. (1950). Creativity. *American Psychologist, 5,* 444-454.

Guilford, J.P. (1975). Creativity: A quarter century of progress. In I.A. Taylor & J.W. Getzels (Eds.), *Perspectives in creativity* (pp. 37-59). Chicago: Aldine.

Hocevar, D., & Michael, W.B. (1979). The effects of scoring formulas on the discriminant validity of tests of divergent thinking. *Educational and Psychological Measurement, 39*, 917-921. doi: 10.1177/001316447903900427.

Hoicka, E., Bijvoet-van den Berg, S., Kerr, T., & Carberry, M. (2013, March). The unusual box test: A non-verbal, non-representational divergent thinking test for toddlers. *In AAAI Spring Symposium: Creativity and (Early) Cognitive Development*.

Houtz, J.C. & Krug, D. (1995). Assessment of creativity: Resolving a mid-life crisis. *Educational Psychology Review, 7*(3), 269-296. doi: 1040-726X/95/0900-0269$07.50/0.

Howell, D.C. (2007). *Statistical methods for psychology* (6th ed.) Belmont, CA: Thomson Wadsworth.

Karwowski, M. (2014). Creative mindsets: Measurement, correlates, consequences. *Psychology of Aesthetics, Creativity, and the Arts, 8*(1), 62-70. doi: 10.1037/a0034898.

Kim, K.H. (2011). The creativity crisis: The decrease in creative thinking scores on the Torrance Tests of Creative Thinking. *Creativity Research Journal, 23*(4), 283-295. doi: 10.1080/ 10400419.2011.627805.

Lau, S. & Cheung, P.C. (2010). Developmental trends of creativity: What twists of turn do boys and girls take at different grades? *Creativity Research Journal*, *22*(3), 329-336.

Lehto, J.E., Juujarvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology, 21* (1), 59-80. Doi:

Lent, R.W., Brown, S.D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. J*ournal of Vocational Behavior, 45*(1), 79-122. doi: 10.1006/jvbe.1994.1027.

Lucas, B.J., & Nordgren, L.F. (2015). People underestimate the value of persistence for creative performance. *Journal of Personality and Social Psychology, 109*(2), 232-243. doi: 10.10 37/pspa0000030.

MacLeoad, C.M. (2991). Half a century of research on Stroop effect: An integrative review. *Psychological Bulletin, 109*(2), 163-203.

Miller, S.E., Marcovitch, S., Boseovski, J.J., & Lewkowicz, D.J. (2015). Young children's ability to use ordinal labels in a spatial search task. *Merrill-Palmer Quarterly, 61*(3), 345-361. doi: 10.13110/merrpalmquar1982.61.3.0345.

Miyake, A., & Friedman, N.P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science, 21*(1), 8-14. doi: 10.1177/0963721411429458.

Miyake, A., Friedman, N.P., Emerson, M.J., Witzki, A.H., Howerter, A., & Wager, T.D. (2000). The unity and diversity of executive functions and their contribution to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49-100. doi: 10.1006/cogp.1999.0734.

Mourgues, C., Barbot, B., Tan, M., & Grigorenko, E.L. (2014). The interaction between culture and the development of creativity. In L.A. Jansen (Ed.) *The Oxford handbook of human development and culture: An interdisciplinary perspective* (pp. 255-270). New York: Oxford University Press. doi: 10.1093/oxfordhb/9780199948550.013.16.

Muller, U., Zelazo, P.D., Hood, S., Leone, T., & Rohrer, L. (2004). Interference control in a new rule use task: Age-related changes, labeling, and attention. *Child Development, 75*(5), 1594-1609. doi: 10.111/j.1467-8624.2004.00759.x.

Nash, W.R. (1974). The effects of a school for the gifted in averting the fourth grade slump in creativity. *Gifted Child Quarterly, 18*(3), 168-170. doi: 10.1177/001698627401800308.

O'Connor, A.J., Nemeth, C.J. & Akutsu, S. (2013). Consequences of beliefs about the malleability of creativity. *Creativity Research Journal, 25,* 155-162. doi: 10.1080/10400419.2013.78739.

O'Neill, S.A. (2011). Developing a young musician's growth mindset: the role of motivation, self-theories, and resiliency. In I. Deliege & J.W. David (Eds.) *Music and the mind: Essays in honour of John Sloboda*. New York: Oxford University Press.

Pillai, N.R. (2017). Using mnemonics to improve vocabulary, boost memory and enhance creativity in the ESL classroom. *The English Teacher, 22,* 62-83.

Plucker, J.A., & Renzulli, J.S. (1999). Psychometric approaches to the study of human creativity. In R.J. Sternberg (Ed.), *Handbook of creativity* (pp. 35-61). New York, NY: Cambridge University Press.

Prencipe, A. & Zelazo, P.D. (2005). Development of affective decision making for self and other: Evidence for the integration of first- and third- person perspectives. *Psychological Science, 16*(7), 501-505. DOI: 10.1111/j.0956-7976.2005.01564.x

Ricketts, J., Nation, K. & Bishop, D.V.M. (2007). Vocabulary is important for some, but not all reading skills. *Scientific Studies of Reading, 11*(3), 235-257. DOI: 10.1080/10888430701344306.

Romer, D., Duckworth, A.L., Sznitman, S., & Park, S. (2010). Can adolescents learn self-control? Delay of gratification in the development of control over risk taking. *Prevention Science, 3*, 319-330, doi: 10.1007/s11121-010-0171-8.

Roskos-Ewoldsen, B., Black, S.R., & Mccown, S.M. (2008). Age-related changes in creative thinking. *Journal of Creative Behavior, 42*(1), 33-55.

Runco, M.A. (1986). Maximal performance on divergent thinking tests by gifted, talented, and non-gifted children. *Psychology in the Schools, 23*(3), 308-315. doi: 10.1002/1520-6807(198607)23:3<308::AID-PITS2310230313>3.0.CO;2-V.

Runco, M.A. (1999). A longitudinal study of exceptional giftedness and creativity. *Creativity Research Journal, 12*(2), 161-164.

Sheskin, D.J. (2004). *Handbook of parametric and nonparametric statistical procedures* (3rd ed.). Boca Raton, FL: CRC Press.

Silvia, P.J., Winterstein, B.P., Willse, J.T., Barona, C.M., Cram, J.T., Hess, K.I., Martinez, J.L., & Richard, C.A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity and the Arts, 2*(2), 68-85. doi: 10.1037/1931-3896.2.2.68.

Sternberg, R.J. (1988). Mental self-government: A theory of intellectual styles and their development. *Human Development, 31*, 197-224.

Sternberg, R.J., & Lubart, T.I. (1995). *Defying the crowd: Cultivating creativity in a culture of conformity*. New York, NY: The Free Press.

Sternberg, R.J., & Lubart, T.I. (1999). The concept of creativity: Prospects and paradigms. In R.J. Sternberg (Ed.), *Handbook of creativity* (pp. 3-15). New York, NY: Cambridge University Press.

Sternberg, R.J., & O'Hara, L.A. (1999). Creativity and intelligence. In R.J. Sternberg (Ed.), *Handbook of creativity* (pp. 251+272). New York, NY: Cambridge University Press.

Tabachnick, B.G., & Fidell, L.S. (2007). *Using multivariate statistics* (5th ed.). Boston: Allyn and Bacon.

Torrance, E.P. (1967). *Understanding the fourth-grade slump in creative thinking*. (Report No. BR-5-0508; CRP-994). Washington, DC: US. Office of Education.

Torrance, E.P. (1968). A longitudinal examination of the fourth grade slump in creativity. *Gifted Child Quarterly, 12*(4), 195-199. doi: 10.1177/001698626801200401.

Torrance, E.P. (1974). *Norms-technical manual: Torrance Tests of Creative Thinking.* Lexington, MA: Ginn and Company.

Wallach, M.A. & Kogan, N. (1965). *Modes of thinking in young children: A study of the creativity-intelligence distinction*. New York, NY: Hold, Rinehart & Winston, Inc.

Waxman, S.R., & Hatch, T. (1992). Beyond the basics: Preschool children label objects flexibly at multiple hierarchical levels. *Journal of Child Language, 19*, 153-166.0

White, H.A., & Shah, P. (2006). Uninhibited imaginations: Creativity in adults with attentiondeficit/hyperactivity disorder. *Personality and Individual Differences, 40*, 1121-1131. doi: 10.1016/j.paid.2005.11.007.

Zabelina, D.L., & Robinson, M.D. (2010). Creativity as flexible cognitive control. *Psychology of Aesthetics, Creativity, and the Arts, 4*(3), 136-143. doi: 10.1037/a0017379.

Zelazo, P. D., Frye, D., & Rapus, T. (1996). An age-related dissociation between knowing rules and using them. *Cognitive Development, 11*(1), 37-63. DOI: 10.1016/s0885-2014(96)90027.

Zelazo, P.D., Muller, U., Frye, D., & Marcovitch, S. (2003). The development of executive function in early childhood. *Monographs of the Society for Research in Child Development, 68*(3), 11-27. doi: 10.1111/j.0037-976X.2003.00261.x.

Zeng, L., Proctor, R.W., & Salvendy, G. (2011). Can traditional divergent thinking tests be trusted in measuring and predicting real-world creativity? *Creativity Research Journal, 23*(1), 24-37. doi: 10.1080/10400419.2011.545713.

LIST OF APPENDICES

APPENDIX A

Brick	Cardboard Box	Shoe	Chair	Dinosaur/ Pelganum	Car/ Bup	Bubble-wand/ Sharitnum	Light-bulb/ Blicket
1. Animal 2. Arts & Crafts 3. Atop 4. Break 5. Build 6. Burn 7. Bury 8. Cover 9. Exercise 10. Experiment 11. Garden 12. Gift 13. Hang 14. Hold 15. Noise 16. Place 17. Play 18. Presentation 19. Prop 20. Protection 21. Senses 22. Sit 23. Stack 24. Stand 25. Storage 26. Throw 27. Tool 28. Usage 29. Weapon 30. Wear 31. Weight	1. Arts & Crafts 2. Break 3. Build 4. Burn 5. Bury 6. Cover 7. Description 8. Experiment 9. Gift 10. Hang 11. Hide 12. Hold 13. Make 14. Place 15. Play 16. Presentation 17. Prop 18. Protection 19. Recycle 20. Senses 21. Shelter 22. Shipping 23. Sit 24. Stack 25. Stand 26. Storage 27. Throw 28. Tool 29. Transportation 30. Usage 31. Weapon 32. Wear 33. Weight	1. Arts & Crafts 2. Atop 3. Break 4. Build 5. Burn 6. Collect 7. Cover 8. Damage 9. Description 10. Experiment 11. Fashion 12. Garden 13. Gift 14. Hang 15. Hide 16. Hold 17. Movement 18. Noise 19. Play 20. Prop 21. Protection 22. Recycle 23. Senses 24. Sit 25. Stack 26. Storage 27. Tie 28. Throw 29. Tool 30. Usage 31. Weapon 32. Wear	1. Action 2. Arts & Crafts 3. Atop 4. Break 5. Build 6. Burn 7. Carry 8. Climb 9. Description 10. Fold 11. Gift 12. Hang 13. Hide 14. Movement 15. Place 16. Play 17. Presentation 18. Protection 19. Recycle 20. Sit 21. Stack 22. Stool 23. Throw 24. Tool 25. Usage 26. Weapon 27. Wear 28. Weight	1. Arts & Crafts 2. Atop 3. Break 4. Build 5. Burn 6. Bury 7. Carry 8. Description 9. Experiment 10. Gift 11. Hang 12. Hold 13. Manipulate 14. Movement 15. Noise 16. Place 17. Play 18. Prop 19. Presentation 20. Protection 21. Senses 22. Stack 23. Stool 24. Throw 25. Tool 26. Trash 27. Usage 28. Weapon 29. Wear 30. Weight	1. Arts & Crafts 2. Atop 3. Break 4. Build 5. Burn 6. Description 7. Experiment 8. Gift 9. Hang 10. Hold 11. Movement 12. Noise 13. Place 14. Play 15. Presentation 16. Prop 17. Protection 18. Senses 19. Sit 20. Stack 21. Stand 22. Throw 23. Tool 24. Transport 25. Trash 26. Usage 27. Weapon 28. Wear 29. Weight	1. Arts & Crafts 2. Atop 3. Break 4. Build 5. Burn 6. Description 7. Experiment 8. Gift 9. Hang 10. Hide 11. Hold 12. Manipulate 13. Movement 14. Noise 15. Place 16. Play 17. Poke 18. Prop 19. Recycle 20. Scoop 21. Senses 22. Sit 23. Stand 24. Throw 25. Tool 26. Trash 27. Usage 28. Weapon 29. Wear 30. Weight	1. Arts & Crafts 2. Atop 3. Blow 4. Break 5. Build 6. Burn 7. Cover 8. Description 9. Experiment 10. Fill 11. Gift 12. Hang 13. Hide 14. Hit 15. Hold 16. Idea 17. Kitchen 18. Light 19. Movement 20. Noise 21. Place 22. Play 23. Poke 24. Prop 25. Protection 26. Recycle 27. Senses 28. Sit 29. Stand 30. Throw 31. Tool 32. Trash 33. Usage 34. Weapon 35. Wear

		33. Weight					36. Weigh t

VITA

EDUCATION

Bachelor of Arts, Psychology May 2009
California State University, Fresno

Master of Arts, Research Psychology January 2014
California State University, Long Beach

TEACHING EXPERIENCE

Long Beach Community College
Tutor

- Helped students prepare for college with an immersion class teaching study skills.
- Aided students in classes across campus including English, Cooking, Psychology, and Math.

University of Mississippi
Graduate Instructor of Record

- "Cognitive Psychology" (Fall 2015, 2 sections: Spring 2016)
- "General Psychology" (Fall 2014, Spring 2015)

University of Mississippi
Statistics Tutor

- Tutored students in introductory statistics

AWARDS AND HONORS

2016 Graduate Instructor Excellence in Teaching Award ($1,000)
2016 Teaching of Psychology Grant ($2,000)
2015 Psi Chi Honor Society
2011 Phi Kappa Phi Honor Society
2008 Honors Program: California State University, Fresno