https://doi.org/10.24839/2325-7342.JN27.1.81

Creativity and Executive Function in School-Age Children: Effects of Creative Coloring and Individual Creativity on an Executive Function Sorting Task

Katherine C. Crenshaw* and Stephanie E. Miller
Department of Psychology, The University of Mississippi

ABSTRACT. We examined the relationship between executive function (EF) and creativity and whether a creative manipulation related to free coloring or coloring task-relevant materials would impact EF performance in the Dimensional Change Card Sort (DCCS). Participants also completed individual difference measures of creativity with an Alternative Uses Task and EF with a Backward Digit Span Working Memory Task and Delay of Gratification Inhibition Task. Although we failed to find a relationship between creativity in the Alternative Uses Task and our EF measures ($rs < .25$, $ps > .10$), we found evidence to suggest the effects of a creative color manipulation differed by individual differences in creativity. Those who were low in certain creative components like the ability to switch between categories ($p = .03$ and $p = .08$), generate a number of unique ideas ($p = .03$ and $p = .04$), and originality ($p = .01$) seemed to perform better when allowed to freely color before the DCCS compared to other conditions. Those who performed higher in creative measures generally did not benefit from a creative manipulation before the task. This suggests that a more nuanced examination of the relationship between creativity and EF considering possible experimental manipulations, multiple components, and individual differences may be useful in understanding the relationship between these 2 constructs.

Keywords: executive function, creativity, school-aged children, art therapy, speech language pathology

Executive function (EF) is an element of higher order cognition important to a variety of skills and abilities, such as communication, academics, and emotional regulation (Diamond et al., 2007; Mohapatra, 2019; Perry et al., 2018). Multiple components likely contribute to EF, such as *working memory* involving the mental manipulation of information, *inhibition* or suppression of prepotent responses, and *cognitive flexibility* involved in switching flexibility between tasks or mental sets (Miyake & Friedman, 2012). However, EF is typically studied from a problem-solving framework where the function of EF is to solve a problem, and failing to solve a problem indicates a failure in EF (Zelazo, 2015; Zelazo et al., 1997). Based on this problem-solving framework, researchers have proposed significant development in EF from early childhood into adolescence that align with advancement in neural circuitry within the prefrontal cortex (PFC; Miller & Wallis, 2013; Zelazo, 2015) and children's abilities to mentally represent and reflect on their representations helpful to controlling behavior (e.g., Marcovitch & Zelazo, 2009; Zelazo, 2015). Although early childhood is a period of tremendous growth, it is also important to consider neuroplasticity and the idea that brain development is responsive to experience. This prolonged development and early responsiveness to experience is likely the reason for the focus on early EF manipulations and intervention (e.g., Best, 2010; Scionti et al., 2020; Zhang et al., 2019).

*Faculty mentor

There are many manipulations within the course of an experiment and in the long term that have been shown to improve EF performance. For example, within the course of an experiment, labeling relevant aspects of a task such as the name of the hiding place in an EF search task benefits EF performance (e.g., Miller & Marcovitch, 2011). In the long term, Diamond and Lee (2011) reviewed a number of studies and found positive effects of interventions involving physical activity on EF, including traditional tae-kwon-do training, which focuses on self-control and discipline, and yoga, which focuses on physical training, mindfulness, and sensory awareness.

To the best of our knowledge, no short-term EF interventions that focus on creativity, or the ability to balance the processes of novel idea generation with appropriate evaluation have been published (but see Moreno et al., 2011, for short-term music training related to EF enhancements). However, there are several reasons why short-term creative manipulations may benefit EF. First, correlational studies reveal a large body of work suggesting that better creativity is related to better EF (e.g., Edl et al., 2014). Bai and Yao (2018) have linked highly creative people to stronger inhibition. Sharma and Babu (2017) found that older adults who possessed above average creativity also performed significantly better on EF tasks. In addition, creativity is associated with the PFC, similar to EF, and this link may even be stronger in younger samples as compared to adults (e.g., Kleibeuker et al., 2013). Thus, creative manipulations could impact performance on EF by stimulating the PFC via a mechanism similar to exercise (Gonen-Yaacovi et al., 2013; Silveira et al., 2019) and thus increase EF performance (Best, 2010; Diamond & Lee, 2011; Kleibeuker et al., 2013).

Second, researchers have found that greater creativity was correlated with other abilities strongly related to EF. For example, Ayperi (2016) found that chess training increased both creativity and theory of mind, an ability with strong ties to EF in childhood (e.g., Miller & Marcovitch, 2012). Also, creativity has strong ties to mindfulness, or the understanding that the world is constantly and subtly changing and adapting to change (Langer, 1989), which was shown to be an effective long-term intervention for EF (Diamond & Ling, 2020; Takacs & Kassai, 2019) and also stimulates the PFC and EF when paired with aerobic exercise (Diamond & Lee, 2011).

Third, creative manipulations could have a theoretical basis in the EF literature. Specifically, representational frameworks (e.g., Marcovitch & Zelazo, 2009; Zelazo, 2004, 2015) suggested that, as children develop in their ability to represent and reflect on their representations of the world, they are better able to control behavior consciously and execute EF. For example, newborns may be primarily motivated based on pain and pleasure (e.g., putting a rattle on their mouth to suck because it is pleasurable), and thus not exercise much EF or control. However, once children begin labeling and representing the world through language and pointing, usually around their first year, they gain the ability to attach experiences to long-term or working memory and control behavior by reflecting on their representations (e.g., the word "rattle" linked to a memory of a toy that can be shaken). Thus, representation and reflection add depth to experiences, allow for more details to be remembered, and may lead to overriding an immediate action and controlled behavior (e.g., deciding to shake instead of suck on the rattle). Related to creativity, encouraging children to more fully represent and reflect on task-relevant information through art with coloring or music rather than language may encourage more accurate EF performance (e.g., Zelazo, 2004). Finally, creativity through visual art has the ability to be motivating for children as it has been reported to bring joy, pride, reduce stress, and enhance the sense of belonging, which are important factors in an EF intervention's effectiveness (Barfield & Driessnack, 2018).

The purpose of the present study was to examine creativity links to EF. First, we examined correlations between measures of creativity and EF to provide further empirical data on the link between creativity and EF in childhood. Creativity was measured via the Alternative Uses Task (Guilford, 1967) that asks participants to come up with all the different and unique ways to use an everyday item. From this, creativity was measured through the following variables: total fluency, which is the total number of intended uses generated; flexibility, which is the number of different categories the uses could fall into; and originality, which is how rare a use was. Children with higher scores are typically thought to be more creative.

EF was measured with a delay of gratification task (Prencipe & Zelazo, 2005) to go in line with the problem-solving framework (Zelazo, 2015; Zelazo et al., 1997) that consisted of asking children whether they would prefer receiving a smaller reward immediately or larger reward later. EF was also measured with a working memory task (Wechsler, 1997) asking children to hold a string of numbers in mind, manipulate that string of numbers mentally, and provide the experimenter with the numbers in backward order. Both tasks presented children with a problem or goal that conflicted with a prepotent response, such as waiting for a reward conflicting with the impulse to get something right away or reversing a string of numbers conflicting with the response to repeat the numbers in forward order. We hypothesized that our measures of creativity and EF would show relations based on prior works that have suggested that creativity and EF are related through correlations and have a theoretical basis through representational frameworks as well (e.g., Edl et al., 2014; Marcovitch & Zelazo, 2009). However, it is also important to note that this work is far from definitive, because results are mixed (e.g., Sharma & Babu, 2017) and more work is needed to demonstrate a robust relation between creativity and EF.

We also examined the effects of a creative art-based intervention on EF using the Dimensional Change Card Sort (DCCS; Zelazo, 2006), which requires cognitive control to sort and match bivalent sorting cards to target card based on conflicting rules (e.g., in the color game, the red car goes with the red flower; in the shape game, the red car goes with the green car). This task was selected because it is age-appropriate for school-age children and allows for the easy integration of creative manipulation within the task. Specifically, we employed three possible creative manipulations before the EF switching task: (a) the color cards condition included a structured coloring activity where participants used a stencil to color stimuli that would be used in the DCCS task to determine whether a specific relevant creative art-based manipulation may encourage children to reflect on the task and improve EF, (b) the free color condition included an unstructured coloring activity where participants could draw freely to determine whether a general creative art-based manipulation before a task influenced EF, and (c) the book condition included a similar delay and interaction with an experimenter who read a short book before the task to provide a noncreative or art-based control. Given that work has demonstrated individual differences in the effectiveness of EF interventions, we also examined whether individual differences in creativity were related to the effectiveness of the art-based creative intervention. We hypothesized that children in the color cards and free color condition would perform better than the noncreative or art-based control, given that art therapy has positive psychological effects. However, we also hypothesized that children in the color cards condition may perform the best because it encouraged children to represent task relevant stimuli through art (e.g., Zelazo, 2004), and using structured art therapy typically is more effective than an unstructured session (Kaimal & Ray, 2016; Kaimal et al., 2017). We had no specific hypothesis for how creative ability might interact with creative manipulations, because these will be conducted in an exploratory fashion.

Methods

Participants

After the study was approved by the University of Mississippi Institutional Review Board, 49 participants were recruited in the southern United States (M_{age} = 9.18 years, *SD* = 1.57, 59% identified as girls, 41% identified as boys). They were all native English speakers. Of parents who reported race, 92% identified as White, 4% identified as White and Hispanic, 2% identified as Arabic and White, and 2% identified as Native American and White. Of parents who reported family income, 65% reported family incomes over $120,000, 23% reported family incomes between $60,000 and $119,999, and the remaining 12% reported family incomes of less than $59,999. Participants were recruited at Pinecrest Summer camp and completed all tasks in one 40-minute session in a quiet building during a free period at the camp conducted by one experimenter.

Procedure

Sessions averaged 30 minutes in length, in which participants completed tasks in a fixed-order: Alternative Uses Task, Backwards Digit Span Working Memory Task, Delay of Gratification Inhibition Task, one of three creative conditions, and the DCCS. A random number generator was used to create a random list of conditions to be run. Participants were assigned the next randomized condition on the sheet as they agreed to participate. Although it is important to note that this did result in unequal sample sizes across conditions, a Levene's test did not reveal evidence of unequal variance between groups, $F(2, 45) = 1.80$, $p = .18$. Participants were offered a small toy from a treasure box filled with toys such as slinkies, whistles, and bouncy balls, and were allowed to keep crayons and rewards from the Delay of Gratification Task.

Measures

Alternative Uses Task (Guilford, 1967)

Participants were given two minutes each to generate "all the different ways" to use a common object (i.e., brick, chair, shoe). For each item, a primary coder evaluated each response as typical (e.g., sit for chair) or atypical (e.g., paperweight for brick), while excluding illogical answers (e.g., doll hair for brick). Two aspects of creativity were scored by a primary coder for each participant. Total fluency was scored as the number of responses generated and added together across all three items. This measure was further divided into total typical fluency and atypical fluency (i.e., the total number of atypical responses—more in line with the instructions of the task asking for different ways to use a common object). Total flexibility was also assessed by assigning each response in a category (e.g., building for brick) then counting each participant's total number of categories across all three items. Originality was scored by three raters for each object using a subjective scoring method, in which each response was scored from 1 (*not creative at all*) to 5 (*highly creative,* defined as being uncommon, remotely linked to the everyday object, and clever/insightful, see Plucker et al., 2011, with correlations between two raters equal to .89 in the original study). The two secondary raters were blind to which and how many responses were generated by each participant. Reliability across the raters for each item was moderate, ICCs > .63, thus we created one originality score by averaging across originality for all items, which were also significantly correlated, rs(47) > .41, ps < .004.

Backwards Digit Span Working Memory Task (Wechsler, 1997)

Participants were read a list of numbers aloud and asked to orally repeat the numbers backwards (e.g., if read 2, 5, the correct response was 5, 2). After a short training in which all participants demonstrated they were able to successfully repeat a set of two numbers backward with feedback, participants completed as many trials as possible until they missed three in a row. Trials were divided into sets and increased in difficulty. For example, Set 1 had three trials with two digits each, Set 2 had three trials with three numbers each, and each subsequent set increased by one digit. The number of trials the participants recalled correctly backward was measured.

Delay of Gratification Inhibition Task (Prencipe & Zelazo, 2005)

Participants were presented with a card depicting a decision where they were asked if they would like a smaller reward now (i.e., pennies, stickers, or erasers) or a larger reward later. The experimenter completed two practice trials for the participant to demonstrate the rules (i.e., the experimenter chose and was given an eraser in that moment instead of receiving it later or the experimenter could choose eight erasers that were placed out of reach in an envelope and were given to him later instead of having 1 eraser at that moment). The rewards were kept in clear containers in front of the participant, and the participant was presented with nine trials with decisions of one now vs. two later, one now vs. four later, and one now vs. six later for each reward. This task was scored by the number of times the participant chose to wait for a larger reward.

DCCS Cognitive Flexibility Task With Art-Based Creative Intervention (Zelazo, 2006)

In the first preswitch phase, children were asked to sort six 4 x 6 inch sorting cards (e.g., blue squares and red circles) into a slot on the top of 8 x 5 x 4 inch boxes marked with a target card (i.e., a blue circle and red square). For example, if children were asked to sort according to color in the preswitch phase, the blue square would be sorted to the blue circle. In the postswitch phase, children were asked to switch and sort by another dimension (e.g., switch to sorting by shape so that the blue square would now be sorted to the red square). Given that all but one participant performed perfectly in the postswitch phase, we examined performance on the last and more difficult borders phase. In this phase, children were presented with a set of 12 cards where they had to switch between sorting rules based on whether the card had a border around the edge of the card (n = 6, sorted by color) or did not have a border around the edge of the card (n = 6, sorted by shape) presented in a pseudorandom order fixed across participants. Performance on the DCCS was scored by measuring accuracy of the card sorting in the borders task.

Art-Based Creative Intervention

Before the DCCS, each participant was randomly assigned to one of the three conditions to assess whether a creative art-based manipulation would influence DCCS performance. The book condition served as a control where participants did not engage in a creative art-based task but did interact with an experimenter as they listened to a 5-minute story (Dr. Seuss's *Oh the Places You'll Go!*) read by the researcher before the DCCS task. In the free color condition, participants engaged in an unstructured creative art-based task where the experimenter gave participants two crayons (i.e., a red and blue crayon) and a piece of 4 x 6 inch paper with the instructions to draw whatever they wanted for five minutes on both the front and back of the card for the entire 5-minute span, even if they said they were done. In the color card condition, participants engaged in a structured creative art-based task that was task-relevant. Participants were asked to create their own target cards for the DCCS with a 4 x 6 index card, crayons, and 3 x 3 inch stencil that matched the other cards. Participants were instructed to pick a shape (i.e., circle or square) and color (i.e., red or blue) and color the stenciled shape carefully (e.g., blue square). Next, they made the other target card with the remaining shape and color (e.g., red circle). Finally, the researcher attached Velcro on the back of the cards to be used as target cards in the DCCS task.

Design Statement

The present study contained experimental and correlational components. The experimental design was within the DCCS with three conditions related to the creative component executed before the DCCS Task. We also included a measure of creativity with the Alternative Uses Task and two additional measures of EF with delay of gratification and working memory tasks. The creativity measure was used to examine the relationship between creativity and EF. The creativity measure also served as an individual difference measure to determine whether the effect of the creativity condition in the DCCS interacted with creativity levels.

Results

Descriptive Statistics

There was no missing data, except for one child who did not have data on the DCCS because they failed to pass the preswitch (see Table 1 for descriptive statistics). As performance on the Backwards Digit Span Working Memory Task and Delay of Gratification Inhibition Task were not correlated, $r = -.03$, $p = .86$, they were considered separately in analyses. We did not find evidence for relationships between EF and creativity, as none of our measures of EF were related to any of our measures of creativity, $rs < .25$, $ps > .10$.

Does EF Performance Differ by Creative Condition?

To examine whether EF performance differed by creative condition, we conducted a general linear model on DCCS performance (number of correct responses out of 12) with condition (3 levels: book, color card, free color) and age (continuous) as predictors. Results demonstrated no significant effect of age, $F(1, 42) = 0.70$, $p = .41$, $\eta^2 = .02$, condition, $F(2, 42) = 0.19$, $p = .83$, $\eta^2 = .01$, or an age by condition interaction, $F(2, 42) = 0.14$, $p = .87$, $\eta^2 = .01$, with regard to number correct on the borders task indicating that age and creative condition did not impact DCCS performance.

Does the Effect of Condition Vary by Children's Creativity Abilities?

For the next set of analyses, we explored whether the effect of condition may vary by children's creativity abilities in fluency, flexibility, and originality. Importantly, within total fluency children's responses could be considered typical or atypical, with atypical responses being more in line with the task instructions to generate different ways to use common objects. Thus, we examined the fluency in responses separated by typical and atypical fluency. For each aspect of creativity, we conducted a general linear model on DCCS borders performance with condition (categorical: 3 levels), creativity element (continuous: total fluency, typical fluency, atypical fluency, flexibility, or originality) and a condition by creativity element interaction as predictors in the model. Given that we found no effect of age, we did not consider age further. A summary of results can be found in Table 2.

Total Fluency

The overall model was not significant, $F(5, 42) = 1.96$, $p = .11$, $\eta^2 = .19$. Only fluency was a significant

TABLE 1

Descriptive Statistics

	M (*SE*)	Range	*n*
Executive Function			
BDS (# correct trials)	7.06 (0.32)	3–13	49
Delay of Gratification (# wait trails)	7.67 (0.21)	5–9	49
DCCS (# correct on borders)	10.83 (0.24)	0–12	48
Book condition	10.81 (0.42)	0–12	16
Free color condition	11.31 (0.35)	0–12	13
Color card condition	10.53 (0.42)	0–12	19
Creativity			
Total fluency	23.20 (1.81)	3–81	49
Total typical fluency	8.94 (0.73)	3–24	49
Total atypical fluency	14.08 (1.73)	0–78	49
Total flexibility	13.53 (0.91)	3–42	49
Total originality	2.00 (0.06)	1–2.9	49

Note. BDS = Backward Digit Span (Working Memory). DCCS = Dimension Change Card Sort Task (Cognitive Flexibility).

predictor of DCCS performance, $F(1, 42) = 6.82$, $p = .01$, $\eta^2 = .14$, which was also reflected in the correlation between DCCS performance and fluency which approached significance when condition was not considered, $r(46) = .27$, $p = .07$.

Typical Fluency. Although the overall model was not significant, $F(5, 42) = 1.78$, $p = .14$, $\eta^2 = .17$, it yielded a significant interaction between condition and total typical fluency, $F(2, 42) = 3.48$, $p = .04$, $\eta^2 = .14$. To further examine the interaction, we did a simple slopes analysis looking at the impact of condition for children one *SD* below the mean on total typical fluency ($M = 3.18$) and one *SD* above the mean on typical fluency ($M = 14.07$). Only those who were one *SD* above the mean on typical fluency had significant differences between conditions, where children who were in the color cards condition performed worse than children in the book condition, $p = .03$, and worse than children in the free color condition, $p = .05$ (see Figure 1).

Atypical Fluency. The overall model approached significance, $F(5, 42) = 2.37$, $p = .06$, $\eta^2 = .22$. Results indicated that all of our predictors were significant: total atypical fluency, $F(1, 42) = 8.77$, $p = .01$, $\eta^2 = .17$, condition, $F(2, 42) = 3.58$, $p = .04$, $\eta^2 = .15$, and the atypical fluency by condition interaction, $F(2, 42) = 3.30$, $p = .05$, $\eta^2 = .14$. To further examine this interaction, we did a simple slopes analysis looking at the impact of condition for children who were one *SD* below the mean on atypical fluency ($M = 2.00$) and one *SD* above the mean on atypical fluency ($M = 26.16$). Those who were one *SD* below the mean on atypical fluency performed better on the DCCS task when in the free color condition compared to color card condition, $p = .03$, and book condition, $p = .04$ (see Figure 2). Those who were one *SD* above the mean on atypical fluency did not have significant differences between conditions, all pairwise comparisons, $p > .17$.

Flexibility

Although the overall model was not significant, $F(5, 42) = 1.78$, $p = .14$, $\eta^2 = .18$, we found a main effect of condition, $F(2, 42) = 3.74$, $p = .03$, $\eta^2 = .15$, qualified by an interaction between condition and total flexibility, $F(2, 42) = 3.37$, $p = .04$, $\eta^2 = .14$. A simple slopes analysis was conducted looking at the impact of condition for children who were one *SD* below the mean on total flexibility ($M = 7.17$) and one *SD* above the mean on total flexibility ($M = 19.894$). Those who were one *SD* below the mean on total flexibility performed worse on the DCCS task when in the color card condition compared to free color, $p = .03$, and this approached significance for the comparison to the book condition, $p = .08$. Those who were one *SD* above the mean on total flexibility had one marginally significant difference between conditions, with better performance on DCCS in color card condition compared to book, $p = .07$ (see Figure 3).

Originality

Although the overall model was not significant, $F(5, 42) = 1.58$, $p = .19$, $\eta^2 = .16$, we found a main effect of condition, $F(2, 42) = 3.48$, $p = .04$, $\eta^2 = .14$,

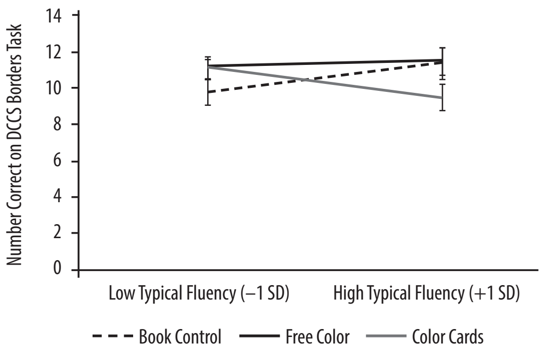
TABLE 2

Summary of Results

Question	
1. Does EF relate to creativity?	None of our EF measures were related to any of our measures of creativity.
2. Does EF differ by creative condition?	There was no effect of age, condition, or an age by condition interaction on DCCS borders performance.
3. Does the effect of condition vary by creative ability?	
a. Total fluency	Higher total fluency related to better performance on DCCS borders.
b. Typical fluency	Children higher in typical fluency performed worse in the color cards condition compared to the book and free color condition on the DCCS.
c. Atypical fluency	Children lower in atypical fluency performed better in the free color condition compared to the color cards and book condition on the DCCS.
d. Flexibility	Children lower in total flexibility performed worse in the color card condition compared to the free color and potentially book condition on the DCCS. Those better on total flexibility potentially performed better in the color card condition compared to the book condition on the DCCS.
e. Originality	Children lower in originality performed better in the free color condition compared to the color cards condition on the DCCS.

FIGURE 1

Simple Slope Analysis for DCCS Borders Performance by Condition and Typical Fluency



Note. Individuals high in typical fluency performed worse in the color cards condition compared to the free color and book control. Bars represent standard errors. DCCS = Dimension Change Card Sort Task.

potentially qualified by a moderately significant interaction between condition and total originality, $F(2, 42) = 3.01$, $p = .06$, $\eta^2 = .13$. The simple slopes analysis examined the effect of condition for children who were one *SD* below the mean on total originality ($M = 1.60$) and one *SD* above the mean on total originality ($M = 2.39$). Those who were one *SD* below the mean had significantly higher DCCS performance in the free color condition compared to the color card condition, $p = .01$. Those who were one *SD* above the mean on total originality did not have significant differences between conditions, all pairwise comparisons $ps > .44$.

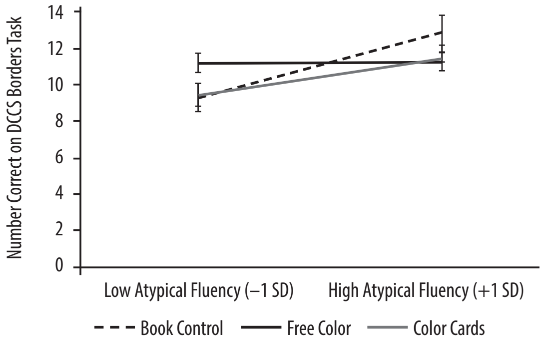
Discussion

The present study aimed to examine the relationship between creativity and EF in a school age sample by examining creativity–EF correlations and the effect of creative manipulations on EF and whether the effectiveness of creative manipulations depended on creative ability. Although results were equivocal, it does point to the need for future research on the relationship between creative ability and EF. The present work did not find evidence for strong relationships between EF and creativity, nor did we find evidence for the utility of a creative manipulation to universally aid in EF processing. However, our results indicated that the impact of a creative manipulation on EF could potentially vary by creative ability. Namely, those who were low in creativity (i.e., high in typical fluency and low in atypical fluency, flexibility, and potentially originality) seemed to benefit from the creative manipulation of free color, but the condition typically did not matter for those who were high in creativity (i.e., low in typical fluency and high in atypical fluency, flexibility, and originality).

Although we found no main effect for the creative manipulations on EF performance as measured by the DCCS, further analysis suggested that creative manipulations may play a role for children who were lower in creativity. It is important to note that, although originality likely best aligns with the definition of creativity related to the ability to generate original and useful ideas, we had several related measures often measured in creativity research related to fluency and flexibility as well. What is perhaps most striking is that results across several measures of creativity suggest that those who scored low in creativity seemed to perform best in the free color condition. More specifically, those who were high in typical fluency, that is those who get stuck on naming typical uses for common items and thus lack “creative” responses, showed

FIGURE 2

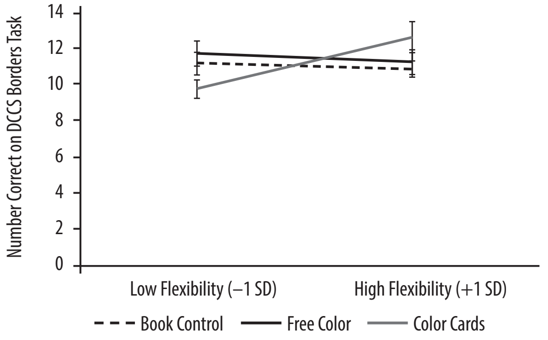
Simple Slope Analysis for DCCS Borders Performance by Condition and Atypical Fluency



Note. Individuals low in atypical fluency performed best in the free color condition compared to the color cards and book control. Bars represent standard errors. DCCS = Dimension Change Card Sort Task.

FIGURE 3

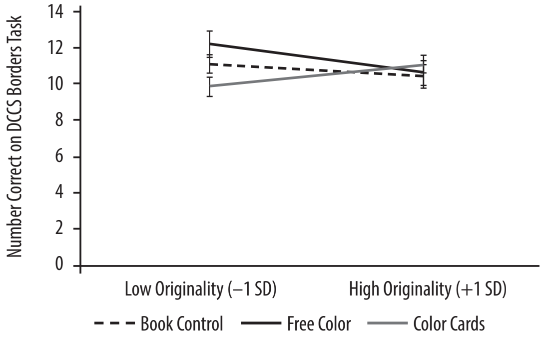
Simple Slope Analysis for DCCS Borders Performance by Condition and Total Flexibility



Note. Individuals low in flexibility performed best in the free color and marginally better in book condition compared to color cards. Individuals high in flexibility performed marginally better in the color cards condition compared to book control. Bars represent standard errors. DCCS = Dimension Change Card Sort Task.

FIGURE 4

Simple Slope Analysis for DCCS Borders Performance by Condition and Originality



Note. Individuals low in originality performed best in the free color compared to color cards. Bars represent standard errors. DCCS = Dimension Change Card Sort Task.

some evidence of worse performance in color card condition compared to both book condition and free color condition. Those low in atypical fluency, that is those who do not name a number of unique uses for common items and thus lack creative responses, seemed to perform worse in the color card condition and the book condition compared to the free color condition. Those low in flexibility, that is those who do not blur categorical boundaries and thus generate more common uses and lack "creative" responses, showed some evidence of worse performance in the color card condition compared to both free color and book conditions. Finally, those low in originality, that is those who cannot generate uncommon, remote, and clever uses and thus lack creative responses, potentially performed worse in the color card condition compared to the free color condition. This result was contrary to our hypotheses, as we expected children to perform better in the color card condition, thinking that this creative task might encourage children to internally represent task-relevant stimuli (e.g., the shape and color of the sorting and target cards; Zelazo, 2004), in addition to any benefits that might be obtained by a creative short-term intervention (Ayperi, 2016).

The fact that our unstructured creative coloring intervention was perhaps the most beneficial for children who were low on creativity is not completely surprising, as research has suggested that coloring intervention can affect behavior in terms of anxiety (Ashlock et al., 2018). It is also important to note that our structured creativity task did not seem to help children any more than the control when they were low in creativity. One possible reason why a structured creative intervention may not aid children low in creativity is the lack of creative thought that goes into the physical art making of task-relevant stimuli. For example, in the free color condition, participants had to actively decide what to draw and how it would look, while for the color card condition, participants simply colored in the lines. To summarize, the free color condition seemed to ask participants to be creative prior to the task, whereas the color card condition merely asked them to complete a task.

It was also interesting to note that those who were already high in creativity received no benefit from creative manipulations, save for those scoring high in flexibility possibly performing better in the structured color card condition. This suggests little support for a structured creative manipulation meant to draw children's focus to task-relevant stimuli to help them perform an EF task, though more work is warranted to see if it may be beneficial for children already high in creativity. Previous work has found that EF gains are typically dependent on individual differences. For example, those who see the most EF improvement in structured intervention are those with low EF (Diamond & Lee, 2011). Therefore, those high in creativity perhaps did not benefit greatly from the creative intervention because their creativity and potentially EF was already at the higher end.

In addition, the present results may point to other individual differences that may be important to measure when examining the effectiveness of a structured and unstructured intervention. For example, base abilities in creativity may be important to understanding how a creative art-based intervention may work. These results might also explain why creativity and EF research has been contested. Indeed, our own results were not able to replicate correlational EF–creativity relationships, and results in this area are mixed, with a few studies claiming a connection (e.g., Edl et al., 2014; Zhao et. al, 2021), whereas others have suggested otherwise (e.g., Sharma & Babu, 2017). One possible explanation for our null findings lie in our lack of power to detect small to medium sized effects. In the present research any indications of potential findings were only for effects that were at least of medium effect size, given our limited sample. Thus, it is possible that the relationship between creativity and EF is likely subtler and more nuanced with potentially smaller effect sizes with considerations of multiple aspects and individual differences in creativity being important (e.g., atypical and typical fluency). Conducting more studies with these individual differences in mind and larger and more controlled samples (e.g., equal participants in each condition) may aid in understanding the nuanced connection between EF and creativity.

Finally, there are many possible interpretations and implications for this research. Although representational frameworks typically examine EF with a focus on a somewhat unitary ability related to the importance of representing and reflecting on task relevant information to guide behavior, it is possible that, by examining this creative intervention within the DCCS, we are limited to understanding the impact of creative manipulations within a cognitive flexibility setting. There is current debate in the field regarding the utility of breaking EF into separable components with little consideration to contextual factors (Doebel, 2020). It will be interesting for research to examine the role of creative manipulations across a broad conceptualization of EF.

Limitations

Limitations of this study include a small sample size as well as unequal group sizes. Therefore, the generalizability and replicability of this study are impacted. In the future, a larger number of participants and equal group sizes should participate to increase the reliability of the study. Also, only one measure of creativity and two measures of EF were conducted. Other studies used different measures, which may account for the differences in the link between creativity and EF. Although our study found no connection between creativity and EF, repeating this study with different creativity and EF measures may produce different results. Likewise, this study repeated with the creative conditions before a different EF task may also produce different results.

Conclusions

In sum, the present work did not find strong evidence for a relationship between EF and creativity but suggested that more work may be useful examining whether the impact of a creative manipulation on EF could vary by creative ability. With regard to implications, several types of therapies focus on using creative art-based intervention to improve children's regulation and EF (Park et al., 2015). Based on our results, it is possible that creative interventions may impact EF, however, individual differences may need to be considered. In particular, speech language pathologists provide treatment intervention for populations who exhibit deficits in EF such as autism spectrum disorder, attention deficit hyperactivity disorder, and Down syndrome (Brunamonti et al., 2011; Chevalère et al., 2019). By adding art therapy ideas into speech language therapy sessions, there is more potential to increase EF, but more research is needed to fully understand how a creative intervention will impact EF. It will be important for future work with larger samples and more targeted age ranges to extend these types of considerations into more applied settings and examine the longevity and generalizability of these effects.

References

Ashlock, L. E., Miller-Perrin, C., & Krumrei-Mancuso, E. (2018). The effectiveness of structured coloring activities for anxiety reduction. *Art Therapy*, *35*(4), 195–201. http://doi.org/10.1080/07421656.2018.1540823

Ayperi, D. S. (2016). An investigation on the effectiveness of chess training on creativity and theory of mind development at early childhood. *Educational Research and Reviews*, *11*(11), 1056–1063. https://doi.org/10.5897/err2016.2676

Bai, X., & Yao, H. (2018). Differences in cognitive inhibition between persons with high and low creativity: Evidences from behavioral and physiological studies. *Acta Psychologica Sinica*, *50*(11), 1197–1211. http://doi.org/10.3724/sp.j.1041.2018.01197

Barfield, P. A., & Driessnack, M. (2018). Children with ADHD draw-and-tell about what makes their life really good. *Journal for Specialists in Pediatric Nursing*, *23*(2), e12210. http://doi.org/10.1111/jspn.12210

Best, J. R. (2010). Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Developmental Review*, *30*(4), 331–351. http://doi.org/10.1016/j.dr.2010.08.001

Brunamonti, E., Pani, P., Papazachariadis, O., Onorati, P., Albertini, G., & Ferraina, S. (2011). Cognitive control of movement in down syndrome. *Research in Developmental Disabilities, 32*(5), 1792–1797. http://doi.org/10.1016/j.ridd.2011.03.008

Chevalère, J., Jauregi, J., Copet, P., Laurier, V., Thuilleaux, D., & Postal, V. (2019). Investigation of the relationship between electrodermal and behavioural responses to executive tasks in Prader-Willi syndrome: An event-related experiment. *Research in Developmental Disabilities, 85*, 229–242. https://doi.org/10.1016/j.ridd.2018.11.013

Diamond, A., Barnett, W. S., Thomas, J., & Munro, S. (2007). Preschool program improves cognitive control. *Science*, *318*(5855), 1387–1388. http://doi.org/10.1126/science.1151148

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *333*(6045), 959–964. http://doi.org/10.1126/science.1204529

Diamond, A., & Ling, D. (2020). Review of the evidence on, and fundamental questions about, efforts to improve executive functions, including working memory. In M. F. Bunting, J. Novick, M. Dougherty, & R. W. Engle (Eds.), *Cognitive and working memory training: Perspectives from psychology, neuroscience, and human development* (pp. 143–385). https://doi.org/10.1093/oso/9780199974467.003.0008

Doebel, S. (2020). Rethinking executive function and its development. *Perspectives on Psychological Science, 15*(4), 942–956. https://doi.org/10.1177/1745691620904771

Edl, S., Benedek, M., Papousek, I., Weiss, E. M., & Fink, A. (2014). Creativity and the Stroop interference effect. *Personality and Individual Differences*, *69*, 38–42. https://doi.org/10.1016/j.paid.2014.05.009

Gonen-Yaacovi, G., Souza, L. C. D., Levy, R., Urbanski, M., Josse, G., & Volle, E. (2013). Rostral and caudal prefrontal contribution to creativity: A meta-analysis of functional imaging data. *Frontiers in Human Neuroscience*, *7*, 465. https://doi.org/10.3389/fnhum.2013.00465

Guilford J. P. (1967). *The nature of human intelligence.* McGraw-Hill.

Kaimal, G., Mensinger, J. L., Drass, J. M., & Dieterich-Hartwell, R. M. (2017). Art therapist-facilitated open studio versus coloring: Differences in outcomes of affect, stress, creative agency, and self-efficacy. *Canadian Art Therapy Association Journal, 30*(2), 56–68. https://doi.org/10.1080/08322473.2017.1375827

Kaimal, G., & Ray, K. (2016). Free art-making in an art therapy open studio: Changes in affect and self-efficacy. *Arts & Health, 9*(2), 154–166. https://doi.org/10.1080/17533015.2016.1217248

Kleibeuker, S. W., Koolschijn, P. C. M., Jolles, D. D., Schel, M. A., Dreu, C. K. D., & Crone, E. A. (2013). Prefrontal cortex involvement in creative problem solving in middle adolescence and adulthood. *Developmental Cognitive Neuroscience*, *5*, 197–206. https://doi.org/10.1016/j.dcn.2013.03.003

Langer, E. (1989). *Mindfulness*. Da Capo Lifelong Books, USA.

Marcovitch, S., & Zelazo, P. D. (2009). A hierarchical competing systems model of the emergence and early development of executive function. *Developmental Science, 12*(1), 1–25. https://doi.org/10.1111/j.1467-7687.2008.00754.x

Miller, S. E., & Marcovitch, S. (2011). Toddlers benefit from labeling on an executive function search task. *Journal of Experimental Child Psychology*, *108*(3), 580–592. https://doi.org/10.1016/j.jecp.2010.10.008

Miller, S. E., & Marcovitch, S. (2012). How theory of mind and executive function co-develop. *Review of Philosophy and Psychology, 3,* 597–625. https://doi.org/10.1007/s13164-012-0117-0

Miller, E. K., & Wallis, J. D. (2013). The prefrontal cortex and executive brain functions. *Fundamental Neuroscience*, 1069–1089. https://doi.org/10.1016/b978-0-12-385870-2.00050-0

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

Mohapatra, B. (2019). Exploring the interaction of executive function and

language processing in adult cognitive-communication disorders. *Clinical Archives of Communication Disorders*, *4*(3), 137–145. https://doi.org/10.21849/cacd.2019.00129
Moreno, S., Bialystok, E., Barac, R., Schellenberg, E. G., Cepeda, N. J., & Chau, T. (2011). Short-term music training enhances verbal intelligence and executive function. *Psychological Science*, *22*(11), 1425–1433. https://doi.org/10.1177/0956797611416999
Park, S., Lee, J.-M., Baik, Y., Kim, K., Yun, H. J., Kwon, H., Jung, Y.-K., & Kim, B.-N. (2015). A preliminary study of the effects of an arts education program on executive function, behavior, and brain structure in a sample of nonclinical school-aged children. *Journal of Child Neurology*, *30*(13), 1757–1766. https://doi.org/10.1177/0883073815579710
Perry, R. E., Braren, S. H., & Blair, C. (2018). Socioeconomic risk and school readiness: Longitudinal mediation through children's social competence and executive function. *Frontiers in Psychology*, *9*, 1544. https://doi.org/10.3389/fpsyg.2018.01544
Prencipe, A., & Zelazo, P. D. (2005). Development of affective decision making for self and other. *Psychological Science, 16*(7), 501–505. https://doi.org/10.1111/j.0956-7976.2005.01564.x
Plucker, J.A., Qian, M., & Wang, S. (2011). Is originality in the eye of the beholder? Comparison of scoring techniques in the assessment of divergent thinking. *The Journal of Creative Behavior*, *45*(1), 1–22. https://doi.org/10.1002/j.2162-6057.2011.tb01081.x
Scionti, N., Cavallero, M., Zogmaister, C., & Marzocchi, G. M. (2020). Is cognitive training effective for improving executive functions in preschoolers? A systematic review and meta-analysis. *Frontiers in Psychology*, *10*, 2812. https://doi.org/10.3389/fpsyg.2019.02812
Sharma, S., & Babu, N. (2017). Interplay between creativity, executive function and working memory in middle-aged and older adults. *Creativity Research Journal*, *29*(1), 71–77. https://doi.org/10.1080/10400419.2017.1263512
Silveira, R., Prado, R. C. R., Brietzke, C., Coelho-Júnior, H. J., Santos, T. M., Pires, F. O., & Asano, R. Y. (2019). Prefrontal cortex asymmetry and psychological responses to exercise: A systematic review. *Physiology & Behavior, 208*, 112580. https://doi.org/10.1016/j.physbeh.2019.112580
Takacs, Z. K., & Kassai, R. (2019). The efficacy of different interventions to foster children's executive function skills: A series of meta-analyses. *Psychological Bulletin*, *145*(7), 653–697. https://doi.org/10.1037/bul0000195
Wechsler, D. (1997). *WAIS-III administration and scoring manual* (3rd ed.). The Psychological Corporation.
Zelazo, P. D. (2004). The development of conscious control in childhood. *Trends in Cognitive Sciences*, *8*(1), 12–17. https://doi.org/10.1016/j.tics.2003.11.001
Zelazo, P. D. (2006). The Dimensional Change Card Sort (DCCS): A method of assessing executive function in children. *Nature Protocols*, *1*(1), 297–301. https://doi.org/10.1038/nprot.2006.46
Zelazo, P. D. (2015). Executive function: Reflection, iterative reprocessing, complexity, and the developing brain. *Developmental Review*, *38*, 55–68. https://doi.org/10.1016/j.dr.2015.07.001
Zelazo, P. D., Carter, A., Reznick, J. S., & Frye, D. (1997). Early development of executive function: A problem-solving framework. *Review of General Psychology*, *1*(2), 198–226. https://doi.org/10.1037//1089-2680.1.2.198
Zhang, Q., Wang, C., Zhao, Q., Yang, L., Buschkuehl, M., & Jaeggi, S. M. (2019). The malleability of executive function in early childhood: Effects of schooling and targeted training. *Developmental science*, *22*(2). https://doi.org/10.1111/desc.12748
Zhao, X., Zhang, W. Y., Tong, D., & Maes, J. H. (2021). Creative thinking and executive functions: Associations and training effects in adolescents. *Psychology of Aesthetics, Creativity, and the Arts*. https://doi.org/10.1037/aca0000392

Author Note. Katherine Crenshaw is now at the University of Memphis, School of Communications Sciences and Disorders.

This research was supported by an award from the Sally McDonnell Barksdale Honors College to the first author. The authors wish to express their thanks to Pinecrest Conference and Recreation Center for their participation and involvement.

Correspondence concerning this manuscript should be addressed to Stephanie Miller, Department of Psychology, University of Mississippi, 207 Peabody, Lyceum Circle, University, Mississippi, 38677. Tel: (662) 915-6541 Fax: (662) 915-5398 Email: semille5@olemiss.edu

Psi Chi Journal of Psychological Research 2021 Reviewers

We sincerely appreciate the hard work on the part of the following individuals who each completed at least one review in 2021. Without the assistance of such dedicated professionals, *Psi Chi Journal* would not be able to function.—Steve Rouse (Editor)

Joanne D. Altman
High Point University

Leslie D. Alvarez
University of Denver

Glena Lynne Andrews
George Fox University

Lara K. Ault
Saint Leo University

Angela Banitt Duncan
Washburn University

Daniel Wade Barrett
Western Connecticut State University

Michelle Beddow
Saginaw Valley State University

Chris Bjornsen
Longwood University

Karen Brakke
Spelman College

MaryAnne Britt
Northern Illinois University

Sheila Brownlow
Catawba College

Candice Burkett
University of Montana Western

Brittany Canfield
California Southern University

Mary Jo Carnot
Chadron State College

Kevin R. Carriere
Washington and Jefferson College

Bradley James Caskey
Birmingham–Southern College

Sarah Cronin
Bemidji State University

Katherine Crowell
University of Hartford

Grace Deason
University of Wisconsin–La Crosse

Teddi S. Deka
Missouri Western State University

Fabiana DesRosiers
Dominican College

Melanie M. Domenech Rodríguez
Utah State University

Martin J. Downing
Lehman College

Gregory S. Drury
Stephen F. Austin State University

Leslie G. Eaton
State University of New York at Cortland

Ryan C. Ebersole
Albany Medical Center

Jorie H. Edwards
Southwestern Oklahoma State University

Deb Esty
Baldwin Wallace University

Devin A. Fava
Saint Vincent College

Shlomit Flaisher-Grinberg
Saint Francis University

Tifani Fletcher
West Liberty University

Andrew Sheldon Franklin
Norfolk State University

Azenett A. Garza Caballero
Weber State University

Rebecca Gilbertson
University of Minnesota Duluth

Jennifer M. Gonder
Farmingdale State College

Heather Haas
University of Montana Western

Thomas F. Harlow
University of Maryland Global Campus

Marya T. Howell-Carter
Farmingdale State College

Robert Hymes
University of Michigan–Dearborn

Lori E. James
University of Colorado Colorado Springs

Fanli Jia
Seton Hall University

Nancy D. Johnson
Queens University of Charlotte

Marla Johnston
Farmingdale State College

Nabil J. Jondi
Hebron University

Allen H. Keniston
University of Wisconsin–Eau Claire

Jackie Kibler
Northwest Missouri State University

Stella G. Lopez
University of Texas at San Antonio

Gina Mariano
Troy University

Tammy McClain
West Liberty University

Tara Mitchell
Lock Haven University

Betsy L. Morgan
University of Wisconsin–La Crosse

Walter Murphy
Texas A&M University–Central Texas

Daniele Nardi
Ball State University

Susan L. O'Donnell
George Fox University

Lindsay A. Phillips
Albright College

Dee Posey
Washington State University

Jessica Rhodes
Westminster College

Lisa Rosen
Texas Woman's University

Raylene Ross
University of South Carolina

David A. Saarnio
Arkansas State University

Donald Saucier
Kansas State University

Pamela Schuetze
Buffalo State College

Christina S. Sinisi
Charleston Southern University

Paul C. Smith
Alverno College

Fernanda Sofio Woolcott
Princeton University

Tammy L. Sonnentag
Xavier University

Kathryn Sperry
Weber State University

Crystal N. Steltenpohl
University of Southern Indiana

Roxanne L. Sullivan
Bellevue University

Jill Swirsky
Holy Family University

Christy Teranishi Martinez
California State University Channel Islands

Christopher Terry
Elmira College

Leonell Torres-Pagan
University of Puerto Rico

Mary Utley
Drury University

Scott VanderStoep
Hope College

Allison A. Vaughn
San Diego State University

Taylor Wadian
University of Cincinnati Blue Ash College

Kathleen West
University of North Carolina at Charlotte

Wayne Wilkinson
Arkansas State University

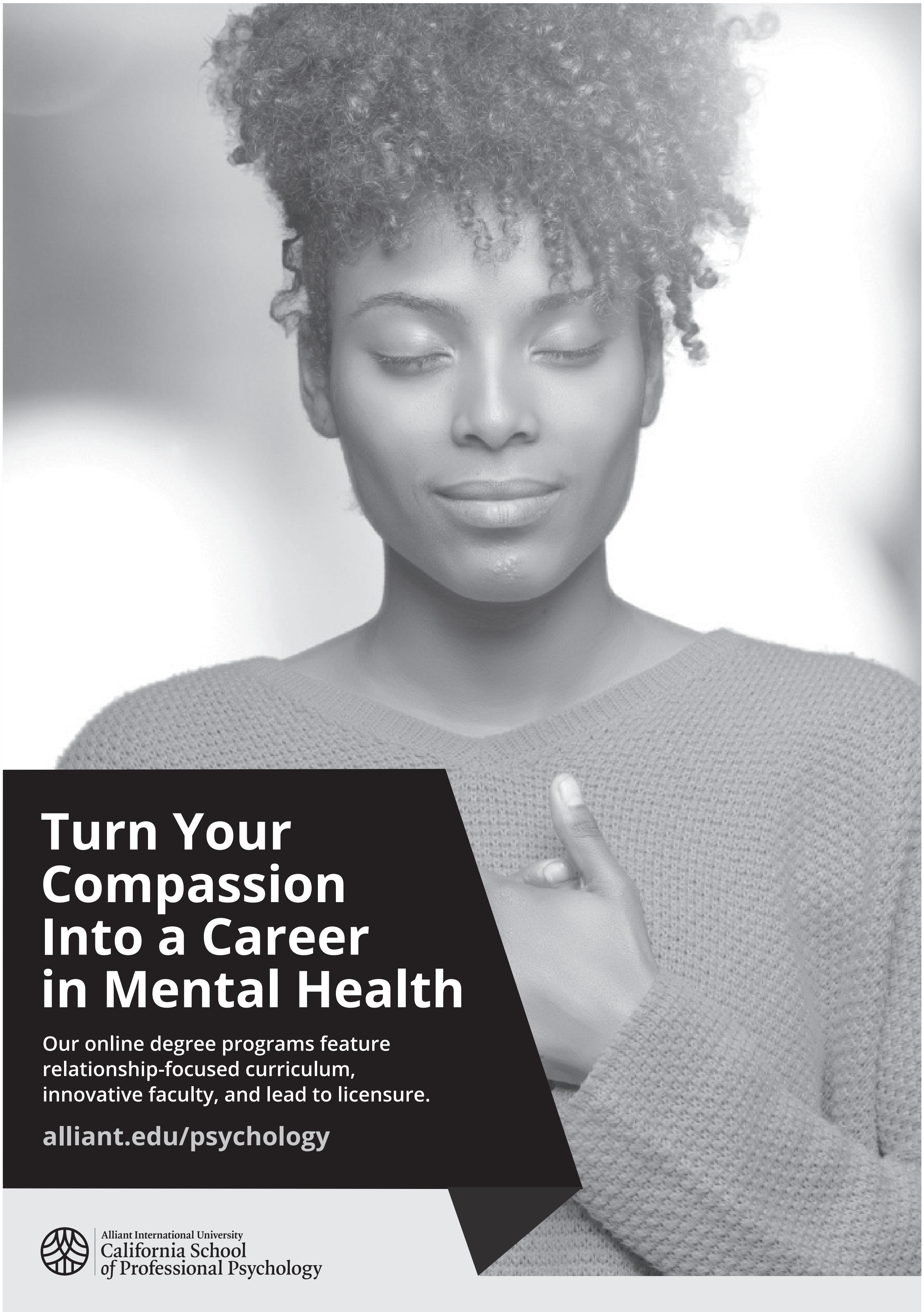
Diane Wille
Indiana University Southeast

J. Austin Williamson
Augustana College

William D. Woody
University of Northern Colorado

Jason R. Young
Hunter College

Evan L. Zucker
Loyola University New Orleans


Turn Your
Compassion
Into a Career
in Mental Health
Our online degree programs feature
relationship-focused curriculum,
innovative faculty, and lead to licensure.
alliant.edu/psychology
Alliant International University
California School
of Professional Psychology

