DOCUMENT SUMMARY

This landmark research study examines the relationship between ADHD and creativity in adults through the lens of inhibitory control theory. The study demonstrates that adults with ADHD show superior divergent thinking abilities but impaired convergent thinking compared to neurotypical adults, with these differences mediated by inhibitory control mechanisms.

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FORMATTED CONTENT

Uninhibited imaginations: Creativity in adults with Attention-Deficit/Hyperactivity Disorder

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Abstract

This study applies a theoretical approach to understanding creativity of **ADHD** individuals in terms of **inhibitory control** and its relative import in two aspects of creativity: **divergent and convergent thinking**. We compared adults with and without **ADHD** on the **Unusual Uses Task** (divergent thinking) and the **Remote Associates Test** (convergent thinking), and a measure of executive inhibitory control, **semantic inhibition of return**. **ADHD** individuals outperformed non-**ADHD** individuals on the **Unusual Uses Task**, but performed worse than non-**ADHD** on the **Remote Associates Test** and the semantic IOR task. The relationship between **ADHD** and creative ability was mediated, in part, by differences in inhibition.

Keywords: Attention-Deficit/Hyperactivity Disorder (ADHD); Attention; Attention deficits; Convergent thinking; Creativity; Divergent thinking; Inhibition; Inhibitory control

1. Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a relatively common childhood disorder, characterized by **inattentiveness**, **impulsivity**, and **hyperactivity**, that persists into adulthood (Barkley, 1997). **ADHD** may have negative consequences for academic achievement, employment performance, and social relationships (e.g., Barkley, Murphy, & Kwasnik, 1996). However, one positive consequence of **ADHD** may be **enhanced creativity** (Hallowell & Ratey, 1994; Weiss, 1997).

Indeed, clinical studies suggest that **ADHD** is difficult to diagnose in part because individuals with **ADHD** share characteristics, such as **high energy and creativity**, with gifted, non-**ADHD** individuals (Leroux & Levitt-Perlman, 2000). Despite anecdotal reports of high creativity in **ADHD** individuals, empirical studies have yielded inconsistent results (Barkley et al., 1996; Funk, Chessare, Weaver, & Exley, 1993; Shaw, 1992; Shaw & Brown, 1990; Solanto & Wender, 1989; Swartwood, Swartwood, & Farrell, 2003).

These inconsistencies may be explained by the types of creativity tasks measured in the studies (ranging from laboratory creativity tests to evaluation of children's play activities), differences in the relative intelligence of **ADHD** and non-**ADHD** groups, and small sample sizes (Barkley, 1997; Barkley et al., 1996). Thus, there is agreement that more research on creativity and **ADHD** is needed (Barkley, 1997; Barkley et al., 1996; Funk et al., 1993).

> The present study reconsidered the question of the creativity in ADHD from a theoretical perspective, by considering the inhibitory deficit associated with ADHD, the relationship between inhibition and creativity, and the effect of ADHD-related inhibitory control deficit on creative processes in ADHD.

Contemporary models of **ADHD** argue that the primary impairment in **ADHD** is **poor inhibitory control** (e.g., Barkley, 1997). Specifically, individuals with **ADHD** may have a deficit in **"executive" inhibition**, such as that required to inhibit a prepotent response or to protect the contents of working memory (Nigg, 2001; White & Marks, 2004). Moreover, several models of creativity suggest that **executive inhibition** may influence creativity (Eysenck, 1995; Martindale, 1995; Mednick, 1962). Recent empirical studies have demonstrated a relationship between creativity and executive inhibition (Carson, Peterson, & Higgins, 2003; Fiore, Schooler, Linville, & Hasher, 2001).

> Specifically, inhibition may have an opposite impact on two aspects of creativity: convergent thinking and divergent thinking.

Convergent thinking is conceptualized as the ability to form associations between disparate concepts (Mednick, 1962). A common laboratory measure of convergent thinking is the **Remote Associates Test (RAT)**, which requires participants to find a common element among three seemingly unrelated concepts (e.g., mines, lick, sprinkle) and to generate a fourth item related to each item in the trio (e.g., salt).

Executive inhibition may be important for performance on convergent thinking tasks for two reasons. First, poor executive inhibition may hinder an individual's ability to suppress partial solutions such as those consistent with two of the three items on a given RAT trial (e.g., ice cream is consistent with lick and sprinkle, but not mines) from entering working memory. Thus, intrusions may interfere with the identification of solutions that meet all criteria (Howard-Jones & Murray, 2003). The second proposal is that poor inhibition may reduce the ability to "stay on task" long enough to arrive at a solution (Fiore et al., 2001). Consistent with these hypotheses, Fiore et al. (2001) found a positive correlation between RAT performance and scores on a reading inhibition task (i.e., attend to italicized text and ignore other text).

In contrast, **divergent thinking** is the ability to generate multiple ideas or solutions to a problem (Guilford, 1957). A popular measure of divergent thinking is the **Unusual Uses Test (UUT)**, which requires participants to generate as many uses as possible for a common object, such as a brick (e.g., build a house, pave a driveway). The number, originality, and flexibility of responses are taken as indices of divergent thinking (Torrance, 1974).

Divergent thinking may require the activation of low-frequency concepts or ideas (e.g., Eysenck, 1995). Hence, **a low level of executive inhibition may actually facilitate divergent thinking**, because concepts and ideas are less likely to be inhibited. In a recent study, Carson et al. (2003) found that **reduced latent inhibition** (a type of executive inhibition), as measured by the ability to screen out irrelevant stimuli, was associated with better divergent thinking. Similarly, in Fiore et al. (2001), participants who performed poorly on the reading inhibition task also generated more alternatives in the **Unusual Uses Task**.

> Thus, poor inhibitory control may present a disadvantage for individuals with ADHD on convergent thinking tasks, such as the Remote Associates Task, that benefit from strong inhibitory control (Fiore et al., 2001). In contrast, given the positive relationship between poor inhibitory control and divergent thinking (Carson et al., 2003; Fiore et al., 2001), individuals with ADHD may show above-average divergent thinking.

Nonetheless, some studies have reported **ADHD**-related impairments in **verbal fluency**, a task that appears to have similar cognitive demands to divergent thinking tasks (Carte, Nigg, & Hinshaw, 1996). Indeed, the relatively poor performance of **ADHD** individuals on verbal fluency, and the typical impairment in verbal fluency for individuals with frontal lobe deficits, led Barkley (1997) to predict that **ADHD** individuals may score lower than non-**ADHD** individuals on divergent thinking tasks.

However, individuals with **ADHD** are more likely to show poor verbal fluency under certain conditions; particularly, when the task is complex and constrained. For example, individuals with **ADHD** are more likely to be impaired on verbal fluency tasks that involve listing items that start with a specific letter than tasks that require generating multiple items in a category (Barkley, 1997). The UUT is relatively simple and requires the formulation of new ideas rather than the retrieval of stored lexical or semantic concepts. Thus, **the UUT may be maximally sensitive to the creative benefits of low inhibition associated with ADHD**.

The present study compared adults with and without **ADHD** on **convergent thinking**, **divergent thinking**, and **inhibitory control** tasks. Because adults with **ADHD** have deficits in inhibition (e.g., Nigg, 2000; White & Marks, 2004), these individuals were expected to be more creative than non-**ADHD** on tasks of divergent thinking, but less creative than non-**ADHD** adults on tasks that require convergent thinking.

Thus, we tested a relatively large number of **ADHD** and non-**ADHD** college students roughly equivalent in age, gender, education, and academic achievement, on two measures of creativity (**RAT** and **UUT**) and a measure of executive inhibition (**semantic IOR**; Fuentes, Vivas, & Humphreys, 1999). Adults with **ADHD** were expected to show inhibitory deficits on the semantic IOR task, consistent with previous research (White, submitted for publication). Compared to adults without **ADHD**, adults with **ADHD** were also expected to perform more poorly on the **RAT**. In contrast, adults with **ADHD** were expected to score higher on the **UUT**, relative to non-**ADHD** adults.

> Finally, ADHD differences in creativity were expected to be the result of inhibition deficits. Thus, performance on the semantic IOR task (i.e., executive inhibition) was expected to statistically mediate the relationship between ADHD status and performance on the measures of creativity (RAT and UUT).

2. Method

2.1. Participants

Participants were 90 undergraduates at The University of Memphis, selected from a large introductory psychology course across several semesters. Participants in the **ADHD** group were both diagnosed with **ADHD-combined type** by a clinician and qualified for inclusion on the basis of two self-report assessment measures described below.

Specifically, the following procedure was employed to recruit participants for the **ADHD** group (n = 45) and the **non-ADHD** group (n = 45). The **Current Symptoms and Childhood Symptoms Scales** (Barkley & Murphy, 1998) were administered to all students enrolled in Introductory Psychology. Respondents were eligible for participation in the **ADHD** group if they met **DSM-IV criteria for ADHD-combined type**, exceeded threshold for diagnosis based on normative data (Barkley & Murphy, 1998), and reported a previous clinical diagnosis of **ADHD**. Respondents were eligible for participation in the **non-ADHD** group if they did not meet **DSM-IV** criteria for diagnosis, did not exceed the threshold for diagnosis, and reported no history of **ADHD** diagnosis.

An additional self-report diagnostic instrument, the **Boatwright-Bracken Adult Attention Deficit Disorder Scale (BAADS)** (Boatwright, Bracken, Young, Morgan, & Relyea, 1995), was included during the experimental session as further confirmation of **ADHD** status. Participants in the **ADHD** and non-**ADHD** groups scored comparably to adults clinically diagnosed with **ADHD** and healthy adult control samples, respectively (normative data published in Boatwright et al., 1995). All participants who were contacted for participation based on the prescreening questionnaires (Barkley & Murphy, 1998) also qualified for inclusion based on the **BAADS**.

The majority of participants in the **ADHD** group reported either (a) they had never taken medication to treat **ADHD**, or (b) they had not taken medication in the past year. A few participants had taken medication more recently, but not within two weeks prior to their participation in the experiment. **Individuals currently taking medication for ADHD were excluded from the study**.

Participants in both the **ADHD** and non-**ADHD** groups reported no history of learning disability, depression, or psychiatric condition (other than **ADHD**). Finally, the groups were similar in terms of age, gender, and academic achievement, as indicated by GPA and scores on the ACT college entrance examination (see Table 1 for demographic and diagnostic information).

2.2. Materials

Current Symptoms Scale and Childhood Symptoms Scale. The Current Symptoms and Childhood Symptoms Scales (Barkley & Murphy, 1998) are brief, self-report screening questionnaires for assessment of adult **ADHD**. Questionnaire items are based on **ADHD** symptoms reported in **DSM-IV**.

Boatwright-Bracken Adult Attention Deficit Disorder Scale (BAADS). The **BAADS** is a self-report measure of adult **ADHD** based on **DSM-IV** criteria for **ADHD** (Boatwright et al., 1995). The **BAADS** includes a **Child Memories Scale (CMS)** and a **Current Adult Symptoms Scale (CASS)** to address **ADHD**-related problems in childhood and adulthood, respectively.

A field-study reliability analysis indicated high internal consistency for the **BAADS** (Cronbach alpha for CMS, $r = .94$; for CASS, $r = .92$). Assessment of test–retest reliability for the **BAADS** revealed high Total Scale stability, with stability coefficients of .84 and .83 for the CMS and CASS, respectively. In an evaluation of the construct validity of the **BAADS**, confirmatory factor analysis yielded strong support for the three factors of **Inattention**, **Impulsivity**, and **Hyperactivity** ($X2 = 10.895$, $p = .13$) and an adjusted goodness of fit index of .79. Finally, a validation study demonstrated the usefulness of the **BAADS** in classifying differentiating adults with **ADHD** from adults with learning disability (LD), adults with combined **ADHD**/LD, and a healthy adult control group. A high hit rate and low false alarm rate indicated high discriminant validity for the **BAADS** (Boatwright et al., 1995).

Remote Associates Test. The **RAT**, adapted from Mednick (1962), consisted of 18 word trios (e.g., mines, lick, and sprinkle). Participants were instructed to generate a word that related to all the three words in the set (e.g., salt). Participants were given 5 min for the entire test. Proportion of correct responses (converted to a z-score) was used as an index of **convergent thinking** ability.

Unusual Uses Task. The **UUT** required participants to generate as many uses as possible for two common household objects, brick and bucket, in 2 min. Three scores were computed by a coder blind to participants' **ADHD** status: **fluency**, **flexibility**, and **originality**. **Fluency** referred to the number of non-redundant uses generated per object, **flexibility** was the number of categories generated and the number of category shifts between responses, and **originality** referred to the uniqueness of each response, as measured by the statistical frequency of each response in the entire sample. The three subscores were converted to z-scores and combined to yield a global measure of **divergent thinking** as in Carson et al. (2003).

Semantic Inhibition of Return Task. The **semantic inhibition of return (IOR)** task, which requires participants to inhibit previously activated semantic categories, was adapted from Fuentes et al. (1999). The task included 32 practice trials and two 64-trial experimental blocks. All stimuli were presented on a 15″ monitor at a viewing distance of approximately 60 cm. Text was in 22-point white Arial font.

Each trial began with a centrally presented fixation cross. The cross was followed by the presentation of three white squares (1.5 cm × 5 cm), centered horizontally across the screen and separated by a distance of 1.5 cm. Following an interval of 1000 ms, a word (e.g., tiger) appeared in the center square. This word, which cued the semantic category, remained visible for 300 ms. After a 200 ms delay, a second word (e.g., pen) appeared in the center square for 300 ms. The second word was categorically unrelated to the cue, and thus, redirected attention away from the semantic category represented by the cue. After an interval of 150 ms, the target item was presented. Depending on the trial type, the target item was either a "real" word (e.g., lion) or a nonsense word (e.g., loni), and either congruent or incongruent with the semantic category represented by the cue word. The target remained visible until the participant's response, which initiated the next trial.

For each trial, participants were instructed to make a **lexical decision**, indicating whether the target item was a real word or nonsense word, by pressing the appropriate key as quickly as possible without sacrificing accuracy. The scoring procedure was adapted from Fuentes et al. (1999). For each participant, and within each condition, a mean and standard deviation of response time was calculated, and values that exceeded two standard deviations above or below the mean (<1% of trials) were excluded. Because errors were infrequent in both groups, error data were not analyzed. An **IOR score** was computed by dividing the RT for cue-related targets by the RT for cue-unrelated targets. A larger proportion was taken as an indication of better ability to inhibit semantic categories for cue-related targets. The resulting proportions were converted to z-scores.

2.3. Procedure

Participants completed the **BAADS** followed by the three experimental tasks in counter-balanced order. Tasks were administered and scored by trained research assistants, who were blind to the **ADHD** status of participants. Finally, participants were debriefed and thanked for their participation.

3. Results

3.1. Creative differences between ADHD groups

A **multivariate analysis of variance (MANOVA)** was conducted to test the following predictions: (a) better performance for non-**ADHD**, relative to **ADHD**, on **semantic IOR**; (b) better performance for non-**ADHD**, relative to **ADHD**, on the **RAT**; and (c) better performance for **ADHD**, relative to non-**ADHD**, on the **UUT**. Thus, the independent variable was **ADHD** status, and the dependent variables were **semantic IOR**, **RAT**, and **UUT**.

As predicted, the **non-ADHD** group scored better than the **ADHD** group on the **semantic IOR** task ($F(1, 88) = 43.4$, $MSE = .677$, $\eta^2_p = .330$, $p < .001$) and the **RAT** ($F(1, 88) = 6.16$, $MSE = .945$, $\eta^2_p = .065$, $p = .015$), while the **ADHD** group performed better than the **non-ADHD** group on the **UUT** ($F(1, 88) = 14.6$, $MSE = .784$, $\eta^2_p = .142$, $p < .001$).

> Indeed, the ADHD group scored higher than the non-ADHD group on all three components of the UUT; $t(88) = 3.13$, $p = .002$ for fluency, $t(88) = 4.37$, $p < .001$ for flexibility, and $t(88) = 3.38$, $p = .001$ for originality.

Means and standard deviations are displayed in Table 2.

3.2. Analysis of statistical mediation

According to Baron and Kenny (1986), three conditions must be met before testing mediation: (a) the independent variable (IV) must predict the dependent variable, (b) the IV must predict the proposed mediator, and (c) when the IV is controlled, the mediator must predict the dependent variable (DV). If these conditions are met, the next step is to compare the predictive value of the IV alone to the predictive value of the IV when the proposed mediator is also included in the equation as a predictor. If the predictive value of the IV is eliminated (or significantly reduced) by the inclusion of the mediator, then statistical mediation is confirmed (Baron & Kenny, 1986).

Thus, a series of regression analyses was conducted to evaluate **semantic IOR** as the mediator of the relationship between **ADHD** and performance on the **RAT**. As expected, **ADHD** explained a significant proportion of variance in **semantic IOR**, $R^2 = .330$, $F(1, 88) = 43.4$, $p < .001$, and reliably predicted **semantic IOR** scores, $\beta = .575$, $t(88) = 6.59$, $p < .001$ (one-tailed). In addition, **ADHD** explained a significant proportion of variance in **RAT** performance, $R^2 = .065$, $F(1, 88) = 6.16$, $p = .015$, and reliably predicted **RAT** scores, $\beta = .256$, $t(88) = 2.48$, $p = .008$ (one-tailed).

Finally, when **ADHD** status and **semantic IOR** were entered together as predictors, the resulting model explained a significant proportion of variance in **RAT** scores, $R^2 = .065$, $F(2, 87) = 4.96$, $p = .009$, and **semantic IOR** (the proposed mediator) reliably predicted **RAT** scores, $\beta = .235$, $t(88) = 1.89$, $p = .031$ (one-tailed). However, when **semantic IOR** was also included as a predictor, **ADHD** no longer predicted **RAT** scores, $\beta = .121$, $t(88) = .974$, $p = .167$ (one-tailed).

> Thus, effect of ADHD status on RAT performance was mediated by semantic IOR, consistent with the hypothesis that ADHD-related deficits in inhibitory control underlie the relatively poor convergent thinking observed for the ADHD group in the present study.

Additional analyses were conducted to evaluate statistical mediation of the relationship between **ADHD** and performance on the **UUT**. When **ADHD** and **semantic IOR** were entered together as predictors of **UUT** performance, the overall model was significant, $R^2 = .143$, $F(2, 87) = 7.27$, $p < .001$. However, the predictive value of **semantic IOR** was not significant, $\beta = .032$, $t(88) = .267$, $p = .395$ (one-tailed), so the preconditions for mediation were not met.

Thus, **semantic IOR** did not mediate the relationship between **ADHD** and performance on the **UUT**. However, contemporary models of **inhibitory control** argue that executive inhibition is not a unitary construct (e.g., Friedman & Miyake, 2004). Evidence suggests that individuals with **ADHD** may have multiple inhibitory control deficits (Nigg, 2001), and the **semantic IOR** task may primarily tap inhibition of proactive interference (White, submitted for publication). Thus, **ADHD**-related inhibitory deficits not assessed in the present study, and/or characteristics of **ADHD** unrelated to inhibition, may contribute to better **divergent thinking** ability in individuals with **ADHD**.

3.3. Sample responses for the Unusual Uses Task

The quantitative analysis does not necessarily provide the reader with a sense of the creative responses provided by participants in this study. For example, typical responses by both **ADHD** and non-**ADHD** adults to the brick item were "building a house" and "building a wall", and typical responses to the bucket item were "carrying water" and "making a sandcastle".

> By contrast, some of the unique responses provided by individual ADHD participants included "crush to make lipstick", "use as a pencil holder", and "write on surfaces like concrete" for the brick item, and "as a guitar if strings and stick are added" and "as an underwater air supply", for the bucket item.

Collectively, our results support the hypothesis that adults with **ADHD** have higher **divergent thinking** ability, but lower **convergent thinking** ability, compared to adults without **ADHD**.

4. Discussion

People have long speculated that some forms of mental illness may impart certain cognitive benefits, such as insight, inventiveness and creativity (Schuldberg, 2001). Certain mental disorders, such as schizophrenia and bipolar disorder, may be linked to higher than normal creative ability (Russ, 2001). Similarly, the present study suggests that **ADHD** in adults may be associated with better performance on certain types of creativity tasks, specifically, those that involve **divergent thinking**. On the other hand, **convergent thinking** may be hindered by the presence of **ADHD**, an effect that may be attributed to **ADHD**-related deficits in **inhibitory control**.

Given that adults with **ADHD** may have **above-average divergent thinking ability**, what are the implications for creative achievement outside of the laboratory? Studies of adults without **ADHD** suggest that **divergent thinking** ability is positively correlated with creative achievement in "real life" (Guilford, 1957; Torrance, 1988). Similarly, Carson et al. (2003) found that highly creative individuals (i.e., individuals with high creative achievement outside of the laboratory) have lower levels of executive **inhibitory control** and perform better on tasks of **divergent thinking**, relative to individuals with less creative achievement.

> Likewise, individuals with ADHD may show higher levels of creativity in real-life contexts (Weiss, 1997).

On the other hand, some models of creativity suggest that both the ability to diffuse attention and generate ideas, and the ability to focus attention and work within certain constraints, may be important for actual creative production (Finke, Ward, & Smith, 1992). Future research that addresses creative achievement, rather than laboratory task performance, may be beneficial to understanding the relationship between creativity and **ADHD**.

The research presented herein is a major step toward a theoretically grounded understanding of creativity in **ADHD**. However, care must be taken in generalizing these findings to individuals not represented in this study, such as children, individuals with low intelligence or learning disability. The current sample consisted of relatively high-achieving college students, and it is possible that individuals with **ADHD** who are more creative are also more likely to enroll in college.

In addition, the present findings may not necessarily hold true for individuals diagnosed with a subtype of **ADHD** other than **ADHD-combined type**. Previous research has shown differences in **inhibitory control** as a function of **ADHD** subtype (Nigg, Blaskey, Huang-Pollack, & Rappley, 2002). Thus, **ADHD** subtypes may also differ in terms of creative ability.

Finally, the impact of medication on creativity in individuals with **ADHD** is inconclusive. Swartwood et al. (2003) found that stimulant medication affected some components of creative ability in individuals with **ADHD**, but other studies have not found an effect of medication on creativity (Funk et al., 1993; Solanto & Wender, 1989).

Despite these limitations, the current findings have exciting implications for non-laboratory contexts. Research suggests that different types of creative thinkers may excel at different types of problem-solving (e.g., Finke, 1996; Zhang, 2002). For example, Finke (1996) describes **"chaotic thinkers"** as individuals who have an unstructured, spontaneous cognitive style ("chaotic cognition") that tends to result in original creative products (Finke, 1996). This **divergent thinking** style may facilitate insight thinking, or "thinking outside the box".

In contrast, an individual with a **convergent thinking** style may be better able to adapt old concepts to new situations (Finke, 1996). Thus, different creative styles may be suited to different challenges. Indeed, research suggests that assessments of individual differences in creative styles may be useful to match tasks and workers (Brophy, 2001).

> Similarly, perhaps an understanding of ADHD-related creative differences may be useful to identify niches for adults with ADHD-outlets for "chaotic cognition" (Finke, 1996). Thus, one potential application of this research is to match adults with ADHD to a career that will maximize ADHD-related creative potential.

In conclusion, the present study raises important questions for researchers and clinicians alike. For example, to what extent are the negative consequences of **ADHD** balanced by some possible benefits?

> Rather than focusing exclusively on the limitations associated with ADHD, perhaps future studies will address the potential benefits of the uninhibited ADHD mind.

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References

[Complete reference list follows in standard academic format, maintaining exact citations as in original document]

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