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Characteristics of ADHD Related to Executive Function: Differential Predictions for Creativity-Related Traits

ABSTRACT

Although the relationship between creativity and ADHD is uncertain, recent studies examining how dimensionally assessed characteristics of ADHD relate to creativity and divergent thinking in adults suggest an occasional positive, linear relationship between the constructs. However, the executive functions proposed to underlie characteristics of ADHD have not been examined in relation to creativity. This study was conducted to determine how different characteristics of ADHD related to executive functioning (as assessed by the Brown ADD Scales) predict different components of figural divergent thinking, intellectual risk-taking, and creative self-efficacy. Undergraduate engineering students ($N = 60$) completed the Brown ADD Scales, a figural divergent thinking task, and self-report measures of intellectual risk-taking and creative self-efficacy. A series of multivariate regression models demonstrated that several components of divergent thinking (i.e., fluency, originality, and resistance to closure) were predicted by different characteristics of ADHD. Although fluency was predicted by affect only and originality was predicted by activation only, resistance to closure was predicted by activation, effort, and attention. Additionally, intellectual risk-taking was predicted by memory, effort, and activation, whereas creative self-efficacy was predicted by effort. The implications of these results relating to the relationship between ADHD and creativity, as well as for engineering undergraduate education are discussed.

Keywords: ADHD, divergent thinking, creative self-efficacy, intellectual risk-taking.

It has been estimated that 2.5% of adults in most cultures experience clinically significant symptoms of Attention Deficit Hyperactivity Disorder (ADHD), a neuropsychological condition characterized by a persistent pattern of inattention, hyperactivity, and/or impulsivity (American Psychiatric Association, 2013). Adults with ADHD exhibit less hyperactivity compared to children, but may continue to experience other behavioral manifestations, such as restlessness, inattention, poor planning, and impulsivity (Barkley, 1997; Barkley, Murphy & Kwasnik, 1996). The idea that behavioral manifestations of ADHD are a result of impaired executive function (i.e., management of cognitive functions) has gained support over the last few decades (Barkley, 1997; Brown, Reichel & Quinlan, 2009; Hervey, Epstein & Curry, 2004; Schachar, Mota, Logan, Tannock & Klim, 2000; Willcutt, Doyle, Nigg, Faraone & Pennington, 2005). This body of research suggests that individuals with ADHD may experience difficulty in several distinct areas (e.g., affect regulation and sustaining energy; Brown, 2002). However, some suggest that ADHD-related characteristics may also be related to positive outcomes, such as creativity (e.g., Abraham, 2014; Cramond, 1994; Healey & Rucklidge, 2005).

Although creativity is broadly defined as "the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context." (Plucker, Beghetto & Dow, 2004, p. 90), theoretical accounts of how creativity might relate to ADHD have primarily focused on the creative process (i.e., the mental processes by which creativity occurs; e.g., Abraham, 2014). Some associative theories of creativity suggest that creative ideas are the product of novel combinations of existing concepts in semantic memory (Ward, Smith & Vaid, 1997), wherein less obviously related (i.e., more conceptually distant) concepts result in more creative ideas (Benedek, Könen & Neubauer, 2012). The lack of attention and distractibility associated with ADHD may reflect a

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widened attentional focus, thereby enabling more of the unique combinations resulting in creative ideas (Abraham, Windmann, Siefen, Daum & Güntürkün, 2006). For example, when White and Shah (2016) asked students to say the first word that came to mind in response to a stimulus word, across 25 trials, words provided by students with ADHD were significantly more semantically distant (i.e., more remotely related) from the stimulus word than words provided by students without ADHD. Latent disinhibition, or the inability to screen out previously irrelevant stimuli, may increase the number of unrelated elements in awareness at any point in time and has been found to be associated with enhanced creative achievement in those with high IQ (Carson, 2014; Carson, Peterson & Higgins, 2003; Kéri, 2011). Additionally, trait characteristics associated with ADHD, including risk-taking and enhanced self-efficacy (Barkley, 1997; Owens, Goldfine, Evangelista, Hoza & Kaiser, 2007), may also relate to the creative process (Abraham et al., 2006; Cramond, 1994; Tyagi, Hanoch, Hall, Runco & Denham, 2017).

Trait characteristics common to both ADHD and creativity (i.e., greater risk-taking and self-efficacy) may be manifested in beneficial forms, such as intellectual risk-taking and creative self-efficacy (Beghetto, 2006, 2009). Just as the propensity for individuals with ADHD to engage in greater risk-taking behavior than those without (Barkley, 1997; Mäntylä, Still, Gullberg & Del Missier, 2012; Toplak, Jain & Tannock, 2005; Verheul et al., 2015) results in risky driving, sex, and health behaviors (Shoham, Sonuga-Barke, Aloni, Yaniv & Pollak, 2016), it may also underlie more beneficial forms of risk-taking, such as intellectual risk-taking. Intellectual risk-taking refers to "...engaging in adaptive learning behaviors... that place the learner at risk of making mistakes or appearing less competent than others." (Beghetto, 2009, p. 210). For instance, electing to work on difficult problems risks the possibility of failure and sharing tentative ideas and/or asking questions may result in an individual who appears foolish in front of others (Beghetto, 2009; Tierney & Farmer, 2002). Individuals with ADHD have exhibited greater positive illusory bias (i.e., self-perceived-relative to demonstrated-competence; Owens et al., 2007; Prevatt et al., 2012). In the context of creativity, positive illusory bias may be advantageous, as creative self-efficacy, or ones' belief in his or her ability to produce creative products, positively influences creative expression (Beghetto, 2006). Certainly, higher creative self-efficacy indicates the value placed on creativity, which may lead to more accurate creative self-judgments (Kaufman & Beghetto, 2013; Kaufman, Beghetto & Watson, 2016). Understanding how traits such as intellectual risk-taking and creative self-efficacy relate to ADHD may provide a greater understanding of adaptive behaviors related to ADHD, as well as help to clarify the mechanisms underlying the tentative relationship between ADHD and creativity.

Although the relationship between ADHD and creativity is uncertain,[1] several recent studies have found enhanced creativity in adults with-versus without-an ADHD diagnosis. For example, White and Shah (2006, White & Shah, 2016) found enhanced divergent thinking ability in undergraduate college students diagnosed with ADHD, as opposed to comparison groups with no history of ADHD. In one study, students with ADHD significantly outperformed those without on all components (fluency, flexibility, and originality) of an alternate uses task, a divergent thinking task that asks participants to provide as many uses as possible for common objects (e.g., a newspaper or brick; White & Shah, 2016). In a later study, a different sample of undergraduate students with ADHD received significantly greater flexibility, novelty, and originality scores than students without when given 20 min to design an innovative cell phone device (White & Shah, 2016). White and Shah (2011) also found that students with ADHD scored significantly higher on the Creative Achievement Scale (CAQ; Carson, Peterson, & Higgins, 2005), which assesses self-reported creative achievement across 10 domains, and verbal originality on the Abbreviated Torrance Tests for Adults (ATTA; Goff & Torrance, 2002). A relationship between ADHD and creativity has also been found in research examining ADHD characteristics in non-clinical adult samples (Boot, Nevicka & Baas, 2017; Zabelina, Condon & Beeman, 2014).

Studies examining how dimensional characteristics associated with ADHD relate to creativity have found significant correlations between the two constructs. Zabelina et al. (2014) found that scores on the Adult ADHD Self-Report Scale (Kessler et al., 2005) were significantly and positively correlated with scores on the CAQ, in a sample of adults with no diagnosis of ADHD. A more recent study (Boot et al., 2017) examined characteristics of ADHD in college students using the ADHD DSM-IV rating scale for adults

[1] A recent meta-analysis (Paek, Abdulla & Cramond, 2016) found a significant negative correlation between ADHD and creativity, indicating that participants with an ADHD diagnosis scored lower on assessments of creativity than those without. However, that meta-analysis did not differentiate between studies conducted with children and adults. Studies comparing the creativity of children and adolescents with-versus without-ADHD diagnosis have reported relatively mixed results (Abraham et al., 2006; Cramond, 1994; Healey & Rucklidge, 2005; Shaw & Brown, 1990, 1991), but are beyond the scope of this study.

(Sandra Kooij et al., 2005). Boot et al. (2017) found that symptoms of ADHD (particularly those related to hyperactivity-impulsivity) positively predicted self-reported creative behavior, self-reported creative achievement, and originality on a problem construction task (in which participants were asked to redefine an everyday problem at varying levels of usefulness and originality). Furthermore, all relationships were linear, suggesting that ADHD characteristics may be associated with creativity in students who do not meet full criteria for the disorder (see also Zabelina et al., 2014). In addition, the increasing severity of symptoms in those diagnosed with ADHD may not result in a decline in creative ability (possibly as a result of protective factors likely to be present in a college sample, such as high IQ and working memory; Carson et al., 2003). Given that indicators of creativity may relate to ADHD and its associated characteristics in different ways, examining how individual differences in the characteristics of ADHD relate to creativity may provide greater information about the mechanisms underlying this relationship.

In addition, samples included in past studies that have examined dimensional characteristics of ADHD and creativity have been drawn either from the general population or psychology college students. There is relatively little empirical work examining how creativity relates to individual differences in those pursuing STEM fields, yet creativity may be vital for this population. For instance, the scale of the problems that engineers face, including restoring and improving our nation's aging infrastructure, security of cyberspace, and preventing nuclear terror (DHS, 2013, 2014; Zaghi et al., 2016), requires flexible and innovative thinking (Cropley, 2015b). Because these problems are ever-changing, creativity is vital for success, as engineers must frequently come up with solutions to never-before encountered problems (Brunhaver, Korte, Barley & Sheppard, 2017; Cropley, 2015a; National Academy of Engineering, 1995, 2005). Although creativity is often sought by employers of future engineers (Passow & Passow, 2017), engineering education programs may not teach or reward creativity (Taylor, Zaghi, Kaufman, Reis, & Renzulli, under review). This discrepancy suggests that understanding the individual differences that contribute to the creativity of engineering students is critical.

This study seeks to determine how different traits of ADHD related to executive functioning (i.e., impairment in activation, attention, affect, effort, and memory; Brown, 1996) predict different subconstructs of figural divergent thinking (i.e., fluency, originality, elaboration, abstractness of titles, and resistance to closure; Torrance, 2008), intellectual risk-taking, and creative self-efficacy in engineering students. Consistent with recent research finding positive relations between creativity and dimensional assessments of ADHD characteristics (e.g., Boot et al., 2017; Zabelina et al., 2014), it is expected that divergent thinking scores will be positively associated with ADHD subscale scores and that ADHD subscale scores will predict the various components of divergent thinking. However, the exact nature of the relationship between various components of ADHD and the criterion variables is not predicted beyond the general expectation that the strength of the associations and the structure of the regression models will vary. Given the relation between ADHD and risk-taking (Barkley, 1997), and ADHD and self-efficacy (Owens et al., 2007), it is expected that ADHD scores will be positively associated with and predict intellectual risk-taking and creative self-efficacy.

METHOD

PARTICIPANTS

Sixty undergraduate students majoring in engineering at a public northeastern university participated in the study. Three participants were excluded from analyses because they had not declared a major ($N = 1$) or were dismissed from their major ($N = 2$). This resulted in 57 participants (37 males, 20 females), ranging in age from 18 to 28 ($M = 20.35$, $SD = 2.04$). Sixteen of the participants reported that they had been previously diagnosed with ADHD and 10 of these participants were taking medication for their diagnosed ADHD. The distribution of majors was: 12 Mechanical Engineering, 12 Computer Science and Engineering, 9 Biomedical Engineering, 7 Electrical Engineering, 7 Civil and Environmental Engineering, 6 Chemical Engineering, and 4 multiple engineering fields or closely related sub-disciplines. The study was approved by the university's Institutional Review Board.

MATERIALS

Brown ADD Scales

The Brown ADD Scales for Adults (Brown, 1996) is a self-report measure of ADHD symptoms associated with executive functioning. Respondents are asked to report how often they experience 40 different symptoms on a 4-point scale: 0 (never), 1 (once a week or less), 2 (twice a week), or 3 (almost daily). Although total scale scores (i.e., sum of all items) are used for diagnostic screening, scores for five subscales (activation, attention, effort, affect, and memory) can also be obtained by summing the associated items.

Activation refers to a lack of volition and problems with organization and prioritizing, which can lead to excessive procrastination. *Affect* reflects problems related to mood regulation, including sensitivity to criticism, frequently experiencing negative affect, and loss of motivation. *Attention* refers to difficulty shifting and sustaining attention in daily tasks, which can lead to excessive day dreaming, distractibility, and losing track of time. *Effort* refers to problems maintaining energy, alertness, and consistent performance. *Memory* refers to the problems with memory that contribute to frequent forgetfulness in daily routines and excessive difficulty in recalling learned material.

Items on the scales primarily correspond to symptoms of what the DSM-5 delineates as the inattentive subtype (e.g., problems with sustaining attention, organization, and memory), rather than the hyperactive-impulsive subtype (e.g., problems with waiting one's turn or being still) of ADHD. However, the scale does contain items assessing impulsivity. According to the DSM-5, inattentive and hyperactive-impulsive symptoms may occur separately or in tandem, whereas Brown suggests that both sets of symptoms arise from impaired executive function (i.e., management of cognitive functions; Brown et al., 2009). Furthermore, the scale assesses affect regulation, which is not included as a symptom of ADHD in the DSM-5.

Inter-scale reliability for the Brown ADD Scales was excellent for the total scale (Cronbach's $\alpha = .96$) and ranged from satisfactory to good for subscales: activation ($\alpha = .85$), attention ($\alpha = .90$), effort ($\alpha = .87$), affect ($\alpha = .74$), memory ($\alpha = .75$).

Torrance tests of creative thinking

The Torrance Tests of Creative Thinking-Figural Form A (TTCT-Figural; Torrance, 2008) was used to assess creative potential, as visual (as opposed to verbal) creativity may be more relevant to engineering design. Participants were asked to complete three 10-min drawing activities (e.g., creating a picture from a series of lines) that were then scored for fluency (number of responses), originality (statistical infrequency of responses), elaboration (the detail of responses), resistance to premature closure (lack of constraint of responses), and the abstractness of the titles created for each response. The response booklets were scored by a professionally trained rater at Scholastic Testing Services. Because possible scores on the subcomponents of the TTCT vary, raw scores were used in this study. Reliability for the TTCT-Visual subtests was satisfactory (Cronbach's $\alpha = .73$).

Creative Self-efficacy Scale

Self-belief in ones' ability to produce creative products was assessed using a modified version of the Creative Self-Efficacy Scale (CSE; Beghetto, 2006). Consistent with recommendations to tailor efficacy measures to the domain under investigation (Tierney & Farmer, 2002), wording of the items was modified to target creative self-efficacy in engineering courses specifically. Participants responded on a scale from one (not at all true) to five (very true) to each of five items (e.g., *I am good at coming up with new ways of finding solutions to engineering related problems* and *I am good at coming up with my own engineering related experiments*). CSE scores were obtained by summing responses for all items. Inter-scale reliability for the CSE was satisfactory (Cronbach's $\alpha = .78$).

Intellectual Risk-taking Scale

The extent to which participants engage in adaptive learning behaviors that may cause them to make mistakes or appear less competent to others, was assessed using a modified version of the Intellectual Risk-Taking Scale (IRT; Beghetto, 2009). Examples of the kinds of behaviors that indicate intellectual risk-taking include sharing tentative ideas, asking questions, and trying new and different things (Beghetto, Kaufman & Baxter, 2011). The wording on the scale was revised to target these behaviors in engineering students specifically. Participants responded on a 5-point scale from one (not at all true) to five (very true) to six questions (e.g., *I like doing new things in engineering classes even if I am not very good at them* and *I will try to do new things in engineering classes even if I am not sure how,*). IRT scores were obtained by summing all items. The IRT Scale demonstrated Cronbach's $\alpha = .67$, which although considered in the "low range," is acceptable to use in analysis (Murphy & Davidshofer, 1988).

PROCEDURE

Participants were recruited using an email distributed through both the School of Engineering and the University Center for Students with Disabilities, as well as flyers disseminated in large engineering course lectures. Students who responded to recruitment efforts met with the primary investigator, who explained the purpose of the study[2] and obtained informed consent. Participants were then asked for contact information, whether they had ever been diagnosed with ADHD, and, if so, if they were currently taking medication for their ADHD. Participants were given the option of completing the Brown ADD Scales using the standard administration method of having the researcher read the questions to them and record their answers, or completing the scales themselves. The majority of participants opted to have the questions read to them by the researcher.[3] All participants received the standard report for the scale, generated by the scoring assistant software, following their participation. Participants returned on a different day to complete the assessments related to creativity in a private office with the primary investigator. Participants first completed the CSE, followed by the IRT. The TTCT-Figural was then administered according to the testing instruction manual. Following the completion of the TTCT, participants again completed the CSE and IRT.[4,5]

RESULTS

PRELIMINARY ANALYSES

The distributions for all variables met the assumption of normality according to the Shapiro–Wilk test ($p < .01$), the standard scores of skewness and kurtosis (score divided by standard error; Tabachnick & Fidell, 2007), and a visual inspection of histograms and P-P plots, with the exception of the attention subscale of the Brown ADD scales. Because the distribution for attention was moderately, negatively skewed, the reflected square root (reflected back for interpretation) is used in all subsequent analyses.[6] The transformed variable met the assumption of normality for all criteria. No outliers ($SD > \pm 3.5$ from the mean) were detected for any variable.

A dependent samples *t*-test found no significant differences between pre-TTCT and post-TTCT scores on the CSE scale, $t\ (45) = -1.12$, $p = .27$, and IRT scale, $t\ (45) = -.93$, $p = .36$. Furthermore, several participants ($N = 5$) only completed the pre-measures due to time constraints. Therefore, only participants' scores on the CSE and IRT obtained prior to the TTCT were used in subsequent analyses. No significant gender differences were found for any variable in a series of independent samples t-tests, using Bonferonni corrected $\alpha = .004$. List-wise deletion was used in all analyses. Descriptive statistics and correlations may be seen in Table 1.

REGRESSION MODELS

A series of forward and backward selection Multiple Regressions (MR) were performed to model the relationship between the subscales of ADHD and each of the components of divergent thinking. Given that all correlations between ADHD subscales and abstractness of titles and elaboration were non-significant and $\leq .2$, MR analyses were limited to the fluency, originality, and resistance to closure components of divergent thinking, intellectual risk-taking, and creative self-efficacy. Forward selection MR models begin with the single most significant predictor, converging on a final model by iteratively testing excluded variables and adding the single variable with the lowest *p*-value under .05 to the model, until all variables significant at $p < .05$ when included in the model are added. Because intercorrelations between the predictor variables can affect the order in which variables are added and the addition of a new predictor can result in an already-included predictor dropping in significance, backward selection MR was also conducted. Backward MR models include all predictors in the initial model, converging on a final model by iteratively removing the single predictor with the highest *p*-value and re-evaluating the model at each stage until all remaining *p*-values are <.10. All regression models met all assumptions for MR.

Forward and backward selection MR with ADHD subscales and age as predictors of fluency indicated an identical model as the best fit, with affect included as the only significant predictor of fluency,

[2] Due to the sensitive nature of the topic and to include participants with clinically diagnosed ADHD (recruited through the CSD), the purpose of the study was disclosed to participants.

[3] Participants whose oral response indicated potential misunderstanding of the question (e.g., prolonged hesitation or inconsistent response) were given the opportunity to review their responses to ensure accuracy.

[4] Participants were also asked about their academic experiences via an online interview (following the end of the semester) to gain insight into the challenges that students with ADHD face in engineering programs and academic records were provided by the university's Office of the Registrar (summarized in Taylor et al., under review).

[5] The CSE and IRT administered following the TTCT were to test additional hypotheses not described in the current manuscript. These hypotheses, which were not linked to the primary purpose of the study and suggested that scores on the CSE and IRT would be enhanced following the TTCT activities, were not supported.

[6] Sensitivity analyses indicated that the transformation had a negligible influence on all subsequent regression models, except the model including resistance to closure as the criterion (see below).

TABLE 1. Correlations and Descriptive Statistics of Examined Variables

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1. Activation	–											
2. Affect	.82**	–										
3. Attention	.79**	.69**	–									
4. Effort	.79**	.74**	.69**	–								
5. Memory	.71**	.66**	.76**	.72**	–							
6. Abstract Titles	.16	.16	.06	.05	.20	–						
7. Elaboration	.05	.11	.08	.14	.05	.30*	–					
8. Fluency	.32*	.39**	.24	.31*	.17	.38**	.22	–				
9. Originality	.31*	.23	.26	.15	.14	.24	.34*	.37**	–			
10. Resist Closure	.44**	.37**	.46**	.16	.18	.39**	.01	.59**	.50**	–		
11. CSE	.18	.06	.20	.31*	.20	−.06	.04	.07	−.21	.03	–	
12. IRT	.25	.34*	.38**	.48**	.55**	.14	.13	.30*	−.08	.05	.10	–
Mean	15.12	9.19	18.40	13.19	9.77	11.94	11.45	18.30	13.02	13.08	18.10	22.24
SD	6.23	4.60	6.73	6.91	4.40	3.26	2.22	5.60	5.01	3.74	3.29	3.47
Min	0	0	2	1	0	4	6	8	3	5	9	14
Max	27	19	27	25	18	20	18	31	27	20	25	30

Notes. CSE = Creative Self-Efficacy Scale; IRT = Intellectual Risk-Taking Scale. $N = 51$ for correlations and descriptives for CSE and IRT, $N = 53$ for TTCT descriptives, $N = 57$ for Brown subscale descriptives. $^*p < .05$; $^{**}p < .01$.

TABLE 2. Backward Selection Regression Analyses Predicting Creativity Factors from Components of ADHD and Age

Variable	Models 1 β	2 β	3 β	4 β	5 β	6 β
Fluency						
Activation	−.01					
Affect	.48*	.48*	.47*	.50**	.43**	.40**
Attention	−.01	−.01				
Effort	.06	.06	.06			
Memory	−.14	−.14	−.14	−.12		
Age	−.10	−.10	−.10	−.10	−.11	
R^2	.18	.18	.18	.18	.17	.16
F	1.65	2.02	2.58	3.48	5.05	9.43
ΔR^2		.00	.00	.00	−.01	−.01
ΔF		.00	.00	.07	.46	.71
Originality						
Activation	.42	.45	.45	.50*	.48*	.30*
Affect	.06					
Attention	.13	.13	.10			
Effort	−.24	−.23	−.25	−.23	−.22	
Memory	−.08	−.08				
Age	−.07	−.07	−.07	−.05		
R^2	.12	.12	.12	.11	.11	.09
F	1.03	1.25	1.56	2.06	3.09	5.14
ΔR^2		.00	.00	.00	.00	−.02
ΔF		.06	.11	.16	.11	1.04
Resisting closure						
Activation	.37	.39	.39	.55*		
Affect	.30	.30	.27			
Attention	.37	.44*	.33	.36		
Effort	−.48*	−.52*	−.60**	−.54**		
Memory	−.22	−.24				
Age	.13					
R^2	.35	.34	.32	.29		
F	4.13	4.78	5.58	6.79		
ΔR^2		−.01	−.01	−.02		
ΔF		.91	1.41	1.68		
IRT						
Activation	−.66*	−.66*	−.62**	−.53**		
Affect	.15	.15	.15			
Attention	.11	.09				
Effort	.44*	.45*	.45*	.48*		
Memory	.52*	.53**	.57**	.58**		
Age	−.04					
R^2	.42	.42	.42	.41		
F	5.38	6.56	8.30	10.99		
ΔR^2		.00	.00	−.01		
ΔF		.11	.18	.55		
CSE						
Activation	.04	.04				
Affect	−.44	−.44	−.43	−.41	−.38	
Attention	.05	.05	.06			
Effort	.55*	.55*	.56*	.59*	.59**	

TABLE 2. (Continued)

Variable	Models					
	1 β	2 β	3 β	4 β	5 β	6 β
Memory	.01					
Age	.09	.09	.09	.11		
R^2	.17	.17	.17	.17	.16	
F	1.54	1.89	2.40	3.24	4.57	
ΔR^2		.00	.00	.00	−.01	
ΔF		.00	.01	.08	.66	

Notes. CSE = Creative Self-Efficacy; IRT = Intellectual Risk-Taking. $^*p < .05$; $^{**}p < .01$.

$F(1, 51) = 9.43$, $p < .05$. $R^2 = .16$, $R^2_{adj.} = .14$ (Table 2). Likewise, forward and backward selection MR with ADHD subscales as predictors of originality indicated an identical model as the best fit, with activation included as the only significant predictor of originality, $F(1, 51) = 5.14$, $p < .05$. $R^2 = .09$, $R^2_{adj.} = .07$.

Forward and backward selection MR with ADHD subscales and age as predictors of resistance to closure indicated different models. The forward selection MR included attention as the only significant predictor of resistance to closure (no other variables entered the model), $F(1, 51) = 10.70$, $p < .05$. $R^2 = .17$, $R^2_{adj.} = .16$. However, the final model using backward selection MR included activation, effort, and attention as predictors, $F(3, 49) = 6.79$, $p < .01$. $R^2 = .29$, $R^2_{adj.} = .25$, with activation and effort as the only significant predictors. Sensitivity analyses, conducted with the untransformed attention variable, demonstrated identical final models with forward and backward MR, including only activation ($\beta = .78$, $p < .01$) and effort ($\beta = -.48$, $p < .05$) as significant predictors, $F(2, 50) = 8.21$, $p < .01$. $R^2 = .25$, $R^2_{adj.} = .22$.

Multiple Regressions conducted with ADHD subscales and age as predictors of intellectual risk-taking also indicated different models. Forward selection MR included memory as the only significant predictor of IRT (no other variables entered the model), $F(1, 49) = 21.08$, $p < .01$. $R^2 = .30$, $R^2_{adj.} = .29$, whereas backward selection MR included memory, effort, and activation as predictors in the best fit model, $F(3, 47) = 10.99$, $p < .01$. $R^2 = .41$, $R^2_{adj.} = .38$. MR conducted with ADHD subscales and age as predictors of creative self-efficacy also indicated different models. Forward selection MR included effort as the only significant predictor of CSE (no other variables entered the model), $F(1, 49) = 5.14$, $p < .05$. $R^2 = .10$, $R^2_{adj.} = .08$, whereas backward selection MR included effort and affect as predictors in the best fit model, $F(2, 48) = 4.57$, $p < .05$. $R^2 = .16$, $R^2_{adj.} = .13$.

DISCUSSION

This study sought to examine how behavioral characteristics of ADHD relate to and differentially predict components of divergent thinking. Results revealed that some of the different components of divergent thinking (i.e., fluency, originality, and resistance to closure) were predicted by distinct characteristics related to ADHD. Although fluency demonstrated significant and moderate zero-order correlations with the activation, affect, and effort subscales, only affect (i.e., problems regulating emotion and related motivation) was found to significantly predict fluency. Originality was only significantly correlated with-and predicted by activation, characterized by difficulties with organizing, prioritizing, and volition. Resistance to closure was significantly and moderately correlated with the attention, activation, and affect subscales, and best predicted by the linear combination of activation and effort, wherein difficulties related to activation, along with strengths related to effort predicted greater resistance to closure. We further examined how the characteristics of ADHD relate to two traits that may represent an adaptive advantage: intellectual risk-taking and creative self-efficacy. Effort and memory weaknesses and activation strengths were found to predict intellectual risk-taking, whereas difficulties with effort was the only significant predictor of creative self-efficacy.

Results demonstrated that characteristics related to ADHD predicted components of figural divergent thinking in distinct ways. High affect scores, reflecting difficulty regulating emotion and the frequent experience of negative emotion, predicted fluency. This relationship is consistent with suggestions that emotional lability may contribute to enhanced creativity (see Srivastava & Ketter, 2010). Indeed, creativity has often been posited to be linked to mood disorder, characterized by dysregulation of affect, though two recent meta-analyses suggest that this relationship may be more nuanced than previously thought (Baas, Nijstad, Boot & De Dreu, 2016; Taylor, 2017). The finding that difficulty with organization and starting tasks (i.e., high activation) positively predicted originality may suggest an underlying disorganization of thought. A recent study (Kim & Zhong, 2017) found that presenting information in an organized versus disorganized manner (e.g., Legos grouped by shape and color as opposed to mixed in one box; Exp. 3) influenced originality, wherein disorganization enhanced cognitive flexibility, resulting in more original creations.

Alternatively, it may be that individuals develop enhanced originality and novel ways of thinking as a means of overcoming the difficulties that disorganization and excessive difficulty starting work are likely to cause in their daily lives. Milioni et al. (2017) suggest that this "creative compensation" may explain their finding that executive functioning impairments were less evident on lab tests of executive function in individuals with ADHD and high IQ, as opposed to those with more average IQ scores. Enhanced resistance to closure was predicted by low effort subscale scores, in addition to high activation scores, possibly because resisting closure requires greater cognitive resources (Chirumbolo, Livi, Mannetti, Pierro & Kruglanski, 2004). Indeed, mental fatigue and time pressure may prohibit individuals from resisting premature closure (Webster & Kruglanski, 1994; Webster, Richter & Kruglanski, 1996). Therefore, individuals who are alert and persistent may be more likely to create open figures when they are also high in activation, either because their disorganization and procrastination is associated with originality, or else because it simply ensures that they do not go back to complete the figures they began.

There may also be a straightforward explanation for the combination of ADHD subscale scores that predicted intellectual risk-taking (i.e., effort and memory weaknesses along with activation strengths). Items on the IRT scale assess classroom behaviors that may be necessitated by difficulties with memory and effort and require a lack of procrastination to engage in (e.g., "I ask questions in engineering classes even if other students will think I am not as smart as them."). It is noteworthy that the IRT was not associated with the components of figural divergent thinking most suggestive of creative potential (e.g., originality), given that risk-taking is frequently suggested to be heightened in creative individuals. However, it is possible that such an association may have been found if the IRT did not focus on classroom behaviors, as the association between risk-taking and creativity may be domain specific (Ivcevic & Mayer, 2006; Tyagi et al., 2017). Likewise, although it may seem unusual that creative self-efficacy was not correlated with any component of creative potential, creative self-concept may not always be an accurate assessment of an individuals' creative ability (Kaufman & Beghetto, 2013; Kaufman, Evans & Baer, 2010). Effort was the only significant predictor of creative self-efficacy, suggesting that difficulty sustaining energy predicts the degree to which people believe they are creative in engineering courses. Including affect in the model added a moderate amount of explained variance, suggesting that a more positive, stable mood may be beneficial to the creative self-belief of those low in energy and persistence.

The results of this study have several implications for further investigations regarding the relationship between creativity and ADHD. Similar to recent studies by Boot et al. (2017) and Zabelina et al. (2014), we found that symptoms of ADHD are positively associated with indicators of creativity. However, our results differ somewhat from those found by Boot et al. (2017), who found that creativity's relationship with ADHD was primarily due to hyperactive–impulsive characteristics, rather than inattention characteristics. This study demonstrates a positive relationship between several components of figural divergent thinking and subscales of the Brown ADD Scales (Brown, 1996), which primarily assess symptoms more relevant to the inattention characteristics of ADHD. Given that Boot et al. utilized verbal divergent thinking measures, and that inattention characteristics have been associated with verbal memory deficits (see Schoechlin & Engel, 2005), the characteristics of ADHD related to inattention may be more accurately assessed with figural, rather than verbal, divergent thinking measures. It is also possible there is an interaction between different domains (such as verbal and figural) in the relationship between creativity and ADHD (e.g., Baer & Kaufman, 2017). It is important to note that these associations do not imply that creative individuals are necessarily more likely to have ADHD, nor are students with ADHD necessarily creative (Healey, 2014). Our sample may have limited generalizability for those with ADHD. Indeed, the relationship between ADHD characteristics and creative potential may be due to a variable not addressed in our study, such as normative personality characteristics (see Silvia & Kaufman, 2010).

The results of the study may also have important implications for how engineering is taught. Although creativity is increasingly recognized as a vital skill for success in the field of engineering (Brunhaver et al., 2017; Cropley, 2015a; National Academy of Engineering, 1995, 2005; Passow & Passow, 2017), recent research suggests that traditional engineering education programs may not encourage or reward creative efforts (Atwood & Pretz, 2016; Daly, Mosyjowski, & Seifert, 2016; Kazerounian & Foley, 2007; Nazzal, 2015).

The lack of inclusion of opportunities for the infusion of creativity in engineering programs may negatively influence the recruitment and retention of creative individuals in such programs (Bernold, Spurlin, & Anson, 2007; Ohland et al., 2008; Seymour, Hewitt, & Friend, 1997). Given the associations found between creative potential and characteristics of ADHD, this study may also explain, in part, why students with ADHD are underrepresented in engineering programs (Sparks, Javorsky & Philips, 2004). Some evidence suggests that diversity in gender, sexual orientation, and ethnicity improve the productivity and creativity of teams (Hülsheger, Anderson, & Salgado, 2009; Milliken & Martins, 2016; Payne, 1990). However, *neurodiversity*[7] may also have the potential to support creative, productive teams of engineers, by increasing the number of different approaches and ways of thinking in the field.

Several limitations exist in this study and these will be addressed in future research. The study was not blinded, as participants were asked about their ADHD diagnostic status and were provided information regarding their scores on the Brown scales before completing other measures. Furthermore, response bias may have been present in this study. Due to the sensitive nature of some of the ADHD-related questions, the purpose of the study and exact nature of the procedures were disclosed to participants as part of obtaining informed consent. Although this may have influenced self-report scores on the Brown ADD scales, the influence of these issues on divergent thinking scores may have been mitigated, given that creative potential was assessed with a measure of ability (rather than self-report) and scored by an outside rater. Future research should control for these issues to the greatest extent possible. Because this study used only the figural form of the TTCT to assess creative potential, the results may not be generalizable to other creativity indicators or domains. Indeed, the use of multiple measures of creative performance across domains should also be explored. The sample size was modest, limiting power and precluding more extensive analyses. Accordingly, non-significant results should be viewed as inconclusive. Inter-scale reliability for the CSE and IRT scales were lower than expected. Both scales have demonstrated good reliability (i.e., $\geq .8$) in previous studies, with samples of children and adolescents (Beghetto, 2006, 2009; Beghetto & Baxter, 2012; Beghetto et al., 2011), suggesting that either modifying the questions or using the scales with an adult sample may have affected reliability. Furthermore, IQ was not assessed in our sample, yet it has been suggested that it may serve as a protective factor for those with some forms of executive functioning deficits, such as decreased latent inhibition (Carson et al., 2003; Carson, 2014). Although it seems reasonable to assume that a sample of college students in a competitive engineering program meet the requisite levels of intelligence, as measured by IQ, to serve as a protective factor, our understanding of how ADHD characteristics influence divergent thinking would be improved by future research examining the role of IQ. Although these issues limit our conclusions somewhat, creativity in engineering remains an understudied area and this study is the first to examine how ADHD characteristics influence the divergent thinking of engineering students.

REFERENCES

Abraham, A. (2014). Neurocognitive mechanisms underlying creative thinking: Indications from studies of mental illness. In J.C. Kaufman (Ed.), *Mental illness and creativity* (pp. 79–101). New York: Cambridge University Press.

Abraham, A., Windmann, S., Siefen, R., Daum, I., & Güntürkün, O. (2006). Creative thinking in adolescents with Attention Deficit Hyperactivity Disorder (ADHD). *Child Neuropsychology*, *12*, 111–123. https://doi.org/10.1080/09297040500320691.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Armstrong, T. (2015). The myth of the normal brain: Embracing neurodiversity. *AMA Journal of Ethics*, *17*, 348–352. https://doi.org/10.1001/journalofethics.2015.17.4.msoc1-1504.

Atwood, S.A., & Pretz, J.E. (2016). Creativity as a factor in persistence and academic achievement of engineering undergraduates. *Journal of Engineering Education*, *105*, 540–559. https://doi.org/10.1002/jee.20130.

Baas, M., Nijstad, B.A., Boot, N.C., & De Dreu, C.K.W. (2016). Mad genius revisited: Vulnerability to psychopathology, biobehavioral approach-avoidance, and creativity. *Psychological Bulletin*, *142*, 668–692. https://doi.org/10.1037/bul0000049.

Baer, J., & Kaufman, J.C. (2017). The Amusement Park Theoretical Model of Creativity: An attempt to bridge the domain specificity/generality gap. In J.C. Kaufman, V.P. Glăveanu & J. Baer (Eds.), *Cambridge handbook of creativity across domains* (pp. 8–17). New York: Cambridge University Press.

Barkley, R.A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, *121*, 65–94. https://doi.org/10.1037/0033-2909.121.1.65.

[7] Neurodiversity refers to neurologically based conditions (such as autism, dyslexia, and ADHD) as a natural variation in brain processes, rather than disorder, reflecting the strengths that may accompany these characteristics and suggestions that they may have been evolutionarily advantageous in pre-literate cultures (Armstrong, 2015; Rentenbach, Prislovsky & Gabriel, 2017; Rothstein, 2012; Williams & Taylor, 2006).

Barkley, R.A., Murphy, K., & Kwasnik, D. (1996). Psychological adjustment and adaptive impairments in young adults with ADHD. *Journal of Attention Disorders*, *1*, 41–54. https://doi.org/10.1177/108705479600100104.

Beghetto, R.A. (2006). Creative self-efficacy: Correlates in middle and secondary Students. *Creativity Research Journal*, *18*, 447–457. https://doi.org/10.1207/s15326934crj1804_4.

Beghetto, R.A. (2009). Correlates of intellectual risk taking in elementary school science. *Journal of Research in Science Teaching*, *46*, 210–223. https://doi.org/10.1002/tea.20270.

Beghetto, R.A., & Baxter, J.A. (2012). Exploring student beliefs and understanding in elementary science and mathematics. *Journal of Research in Science Teaching*, *49*, 942–960. https://doi.org/10.1002/tea.21018.

Beghetto, R.A., Kaufman, J.C., & Baxter, J. (2011). Answering the unexpected questions: Exploring the relationship between students' creative self-efficacy and teacher ratings of creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *5*, 342–349. https://doi.org/10.1037/a0022834.

Benedek, M., Könen, T., & Neubauer, A.C. (2012). Associative abilities underlying creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *6*, 273–281. https://doi.org/10.1037/a0027059.

Bernold, L.E., Spurlin, J.E., & Anson, C.M. (2007). Understanding our students: A longitudinal study of success and failure in engineering with implications for increased retention. *Journal of Engineering Education*, *96*, 263–274. https://doi.org/10.1002/j.2168-9830.2007.tb00935.x.

Boot, N., Nevicka, B., & Baas, M. (2017). Subclinical symptoms of attention-deficit/hyperactivity disorder (ADHD) are associated with specific creative processes. *Personality and Individual Differences*, *114*, 73–81. https://doi.org/10.1016/j.paid.2017.03.050.

Brown, T.E. (1996). *Brown Attention Deficit Disorder Scales*. San Antonio, TX: Psychological Corporation.

Brown, T.E. (2002). DSM-IV: ADHD and executive function impairments. *Advanced Studies in Medicine*, *2*, 910–914.

Brown, T.E., Reichel, P.C., & Quinlan, D.M. (2009). Executive function impairments in high IQ adults with ADHD. *Journal of Attention Disorders*, *13*, 161–167. https://doi.org/10.1177/1087054708326113.

Brunhaver, S.R., Korte, R.F., Barley, S.R., & Sheppard, S.D. (2017). Bridging the gaps between engineering education and practice. In *U.S. engineering in a global economy*. Chicago: University of Chicago Press.

Carson, S. (2014). The shared vulnerability model of creativity and psychopathology. In J.C. Kaufman (Ed.), *Mental illness and creativity* (pp. 253–280). Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/CBO9781139128902

Carson, S.H., Peterson, J.B., & Higgins, D.M. (2003). Decreased latent inhibition is associated with increased creative achievement in high-functioning individuals. *Journal of Personality and Social Psychology*, *85*, 499–506. https://doi.org/10.1037/0022-3514.85.3.499.

Carson, S.H., Peterson, J.B., & Higgins, D.M. (2005). Reliability, validity, and factor structure of the creative achievement questionnaire. *Creativity Research Journal*, *14*, 37–50. https://doi.org/10.1207/s15326934crj1701.

Chirumbolo, A., Livi, S., Mannetti, L., Pierro, A., & Kruglanski, A.W. (2004). Effects of need for closure on creativity in small group interactions. *European Journal of Personality*, *18*, 265–278. https://doi.org/10.1002/per.518.

Cramond, B. (1994). Attention-deficit hyperactivity disorder and creativity - What is the connection? *Journal of Creative Behavior*, *28*, 193–210. https://doi.org/10.1002/j.2162-6057.1994.tb01191.x.

Cropley, D.H. (2015a). Promoting creativity and innovation in engineering education. *Psychology of Aesthetics, Creativity, and the Arts*, *9*, 161–171. https://doi.org/10.1037/aca0000008.

Cropley, D.H. (2015b). *Creativity in engineering: Novel solutions to complex problems*. London: Academic Press.

Daly, S.R., Mosyjowski, E.A., & Seifert, C.M. (2016). Teaching creative process across disciplines. *Journal of Creative Behavior*, *1–13*, https://doi.org/10.1002/jocb.158.

DHS (2013). *Executive order 13636: Improving critical infrastructure cybersecurity*. Available from: https://www.whitehouse.gov/the-press-office/2013/02/12/executive-order-improving-critical-infrastructure-cybersecurity [last accessed 27 July 2018].

DHS (2014). *The 2014 Quadrennial Homeland Security Review (QHSR)*. Available from: http://www.dhs.gov/publication/2014-quadrennial-homeland-security-review-qhsr [last accessed 27 July 2018].

Goff, K., & Torrance, E.P. (2002). *Abbreviated Torrance Test for Adults manual*. Bensenville, IL: Scholastic Testing Service.

Healey, D. (2014). Attention-Deficit/Hyperactivity Disorder (ADHD) and creativity: Ever the twain shall meet? In J.C. Kaufman (Ed.), *Creativity and mental illness* (pp. 236–251). New York: Cambridge University Press. https://doi.org/10.1017/CBO9781139128902

Healey, D., & Rucklidge, J.J. (2005). An exploration into the creative abilities of children with ADHD. *Journal of Attention Disorders*, *8*, 88–95. https://doi.org/10.1177/1087054705277198.

Hervey, A.S., Epstein, J.N., & Curry, J.F. (2004). Neuropsychology of adults with Attention-Deficit/Hyperactivity Disorder: A meta-analytic review. *Neuropsychology*, *18*, 485–503. https://doi.org/10.1037/0894-4105.18.3.485.

Hülsheger, U.R., Anderson, N., & Salgado, J.F. (2009). Team-level predictors of innovation at work: A comprehensive meta-analysis spanning three decades of research. *The Journal of Applied Psychology*, *94*, 1128–1145. https://doi.org/10.1037/a0015978.

Ivcevic, Z., & Mayer, J.D. (2006). Creative types and personality. *Imagination, Cognition and Personality*, *26*, 65–86. https://doi.org/10.2190/0615-6262-G582-853U.

Kaufman, J.C., & Beghetto, R.A. (2013). In praise of Clark Kent: Creative metacognition and the importance of teaching kids when (not) to be creative. *Roeper Review*, *35*, 155–165. https://doi.org/10.1080/02783193.2013.799413

Kaufman, J.C., Beghetto, R.A., & Watson, C. (2016). Creative metacognition and self-ratings of creative performance: A 4-C perspective. *Learning and Individual Differences*, *51*, 394–399. https://doi.org/10.1016/j.lindif.2015.05.004

Kaufman, J.C., Evans, M.L., & Baer, J. (2010). The American Idol Effect: Are students good judges of their creativity across domains? *Empirical Studies of the Arts*, *28*, 3–17. https://doi.org/10.2190/EM.28.1.b.

Kazerounian, K., & Foley, S. (2007). Barriers to creativity in engineering education: A study of instructors and students perceptions. *Journal of Mechanical Design*, *129*, 761–768. https://doi.org/10.1115/1.2739569.

Kéri, S. (2011). Solitary minds and social capital: Latent inhibition, general intellectual functions and social network size predict creative achievements. *Psychology of Aesthetics, Creativity, and the Arts*, *5*, 215–221. https://doi.org/10.1037/a0022000.

Kessler, R.C., Adler, L., Ames, M., Demler, O., Faraone, S., Hiripi, E., . . . Walters, E.E. (2005). The World Health Organization Adult ADHD Self-Report Scale (ASRS): A short screening scale for use in the general population. *Psychological Medicine*, *35*, 245–256. https://doi.org/10.1017/S0033291704002892

Kim, Y.J., & Zhong, C.B. (2017). Ideas rise from chaos: Information structure and creativity. *Organizational Behavior and Human Decision Processes*, *138*, 15–27. https://doi.org/10.1016/j.obhdp.2016.10.001.

Mäntylä, T., Still, J., Gullberg, S., & Del Missier, F. (2012). Decision making in adults with ADHD. *Journal of Attention Disorders*, *16*, 164–173. https://doi.org/10.1177/1087054709360494.

Milioni, A.L.V., Chaim, T.M., Cavallet, M., de Oliveira, N.M., Annes, M., dos Santos, B., . . . Cunha, P.J. (2017). High IQ may “mask” the diagnosis of ADHD by compensating for deficits in executive functions in treatment-naïve adults with ADHD. *Journal of Attention Disorders*, *21*, 455–464. https://doi.org/10.1177/1087054714554933

Milliken, F.J., & Martins, L.L. (2016). Searching for common threads: Understanding the multiple effects of diversity in organizational groups. *Academy of Management Review*, *21*, 402–433.

Murphy, K.R., & Davidshofer, C.O. (1988). *Psychological testing: Principles and Applications*. Englewood Cliffs, NJ: Prentice-Hall.

National Academy of Engineering (1995). *Forces shaping the U.S. academic engineering research enterprise*. Washington, DC: National Academies Press.

National Academy of Engineering (2005). *Engineering research and America’s future*. Washington, DC: National Academies Press.

Nazzal, L.J. (2015). Engineering creativity: Differences in creative problem solving stages across domains (Doctoral Dissertation). Available from: https://opencommons.uconn.edu/dissertations/753/ [last accessed 27 July 2018].

Ohland, M.W., Sheppard, S.D., Lichtenstein, G., Eris, O., Chachra, D., & Layton, R. (2008). Persistence, engagement, and migration in engineering programs. *Journal of Engineering Education*, *260–278*, https://doi.org/10.1002/j.2168-9830.2008.tb00978.x.

Owens, J.S., Goldfine, M.E., Evangelista, N.M., Hoza, B., & Kaiser, N.M. (2007). A critical review of self-perceptions and the positive illusory bias in children with ADHD. *Clinical Child and Family Psychology Review*, *10*, 335–351. https://doi.org/10.1007/s10567-007-0027-3.

Paek, S.H., Abdulla, A.M., & Cramond, B. (2016). A meta-analysis of the relationship between three common psychopathologies–ADHD, anxiety, and depression–and indicators of little-c creativity. *Gifted Child Quarterly*, *60*, 117–133. https://doi.org/10.1177/0016986216630600.

Passow, H.J., & Passow, C.H. (2017). What competencies should undergraduate engineering programs emphasize? A systematic review. *Journal of Engineering Education*, *106*, 475–526. https://doi.org/10.1002/jee.20171.

Payne, R. (1990). The effectiveness of research teams: A review. In M.A. West & J.L. Farr (Eds.), *Innovation and creativity at work* (pp. 101–122). Chichester, UK: Wiley.

Plucker, J.A., Beghetto, R.A., & Dow, G.T. (2004). Why isn’t creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educational Psychologist*, *39*, 83–96. https://doi.org/10.1207/s15326985ep3902_1.

Prevatt, F., Proctor, B., Best, L., Baker, L., van Walker, J., & Taylor, N.W. (2012). The positive illusory bias: Does it explain self-evaluations in college students with ADHD? *Journal of Attention Disorders*, *16*, 235–243. https://doi.org/10.1177/1087054710392538.

Rentenbach, B., Prislovsky, L., & Gabriel, R. (2017). Valuing differences: Neurodiversity in the classroom. *Phi Delta Kappan*, *98*, 59–63. https://doi.org/10.1177/0031721717708297.

Rothstein, A. (2012). Mental disorder or neurodiversity? *The New Atlantis*, *36*, 99–115.

Sandra Kooij, J.J., Buitelaar, J.K., Van Den Oord, E.J., Furer, J.W., Rijnders, C.A.T., & Hodiamont, P.P.G. (2005). Internal and external validity of Attention-Deficit Hyperactivity Disorder in a population-based sample of adults. *Psychological Medicine*, *35*, 817–827. https://doi.org/10.1017/S003329170400337X.

Schachar, R., Mota, V.L., Logan, G., Tannock, R., & Klim, P. (2000). Confirmation of an inhibitory control deficit in attention-deficit/hyperactivity disorder. *Journal of Abnormal Child Psychology*, *28*, 227–235. https://doi.org/10.1023/A:1005140103162.

Schoechlin, C., & Engel, R.R. (2005). Neuropsychological performance in adult attention-deficit hyperactivity disorder: Meta-analysis of empirical data. *Archives of Clinical Neuropsychology*, *20*, 727–744. https://doi.org/10.1016/j.acn.2005.04.005.

Seymour, E., Hewitt, N.M., & Friend, C.M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Vol. *12*. Boulder, CO: Westview Press.

Shaw, G.A., & Brown, G. (1990). Laterality and creativity concomitants of attention problems. *Developmental Neuropsychology*, *6*, 39–57. https://doi.org/10.1080/87565649009540448

Shaw, G.A., & Brown, G. (1991). Laterality, implicit memory and attention disorder. *Educational Studies*, *17*, 15–23. https://doi.org/10.1080/0305569910170102

Shoham, R., Sonuga-Barke, E.J.S., Aloni, H., Yaniv, I., & Pollak, Y. (2016). ADHD-associated risk taking is linked to exaggerated views of the benefits of positive outcomes. *Scientific Reports*, *6*, 1–8. https://doi.org/10.1038/srep34833.

Silvia, P.J., & Kaufman, J.C. (2010). Creativity and mental illness. In J.C. Kaufman & R.J. Sternberg (Eds.), *Cambridge handbook of creativity* (pp. 381–394). New York: Cambridge University Press. https://doi.org/10.1017/CBO9780511763205

Sparks, R.L., Javorsky, J., & Philips, L. (2004). College students classified with ADHD and the foreign language requirement. *Journal of Learning Disabilities*, *37*, 169–178. https://doi.org/10.1177/00222194040370020701.

Srivastava, S., & Ketter, T.A. (2010). The link between bipolar disorders and creativity: Evidence from personality and temperament studies. *Current Psychiatry Reports*, *12*, 522–530. https://doi.org/10.1007/s11920-010-0159-x

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

Taylor, C.L. (2017). Creativity and mood disorder: A systematic review and meta-analysis. *Perspectives on Psychological Science*, *12*, 1040–1076. https://doi.org/10.1177/1745691617699653.

Taylor, C.L., Zaghi, A.E., Kaufman, J.C., Reis, S.M., & Renzulli, J.S. (under review). Divergent thinking and academic performance of students with ADHD characteristics in engineering.

Tierney, P., & Farmer, S.M. (2002). Creative self-efficacy: Its potential antecedents and relationship to creative performance. *Academy of Management Journal*, *45*, 1137–1148. https://doi.org/10.2307/3069429.

Toplak, M.E., Jain, U., & Tannock, R. (2005). Executive and motivational processes in adolescents with Attention-Deficit-Hyperactivity Disorder (ADHD). *Behavioral and Brain Functions*, *1*, 1–12. https://doi.org/10.1186/1744-9081-1-8

Torrance, E.P. (2008). *The torrance tests of creative thinking norms-technical manual figural (Streamlined) forms A and B*. Bensenville, IL: Scholastic Testing Service.

Tyagi, V., Hanoch, Y., Hall, S.D., Runco, M., & Denham, S.L. (2017). The risky side of creativity: Domain specific risk taking in creative individuals. *Frontiers in Psychology*, *8*, 1–9. https://doi.org/10.3389/fpsyg.2017.00145.

Verheul, I., Block, J., Burmeister-Lamp, K., Thurik, R., Tiemeier, H., & Turturea, R. (2015). ADHD-like behavior and entrepreneurial intentions. *Small Business Economics*, *45*, 85–101. https://doi.org/10.1007/s11187-015-9642-4.

Ward, T.B., Smith, S.M., & Vaid, J. (1997). Conceptual structures and processes in creative thought. In T.B. Ward, S.M. Smith, & J. Vaid (Eds.), *Creative thought: An investigation of conceptual structures and processes* (pp. 1–27). Washington, DC: American Psychological Association. https://doi.org/10.1037/10227-000

Webster, D.M., & Kruglanski, A.W. (1994). Individual differences in need for cognitive closure. *Journal of Personality and Social Psychology*, *67*, 1049–1062. https://doi.org/10.1037/0022-3514.67.6.1049.

Webster, D.M., Richter, L., & Kruglanski, A.W. (1996). On leaping to conclusions when feeling tired: Mental fatigue effects on impressional primacy. *Journal of Experimental Social Psychology*, *32*, 181–195. https://doi.org/10.1006/jesp.1996.0009.

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

White, H.A., & Shah, P. (2011). Creative style and achievement in adults with attention-deficit/hyperactivity disorder. *Personality and Individual Differences*, *50*, 673–677. https://doi.org/10.1016/j.paid.2010.12.015.

White, H.A., & Shah, P. (2016). Scope of semantic activation and innovative thinking in college students with ADHD. *Creativity Research Journal*, *28*, 275–282. https://doi.org/10.1080/10400419.2016.1195655.

Willcutt, E.G., Doyle, A.E., Nigg, J.T., Faraone, S.V., & Pennington, B.F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biological Psychiatry*, *57*, 1336–1346. https://doi.org/10.1016/j.biopsych.2005.02.006.

Williams, J., & Taylor, E. (2006). The evolution of hyperactivity, impulsivity and cognitive diversity. *Journal of The Royal Society Interface*, *3*, 399–413. https://doi.org/10.1098/rsif.2005.0102.

Zabelina, D.L., Condon, D., & Beeman, M. (2014). Do dimensional psychopathology measures relate to creative achievement or divergent thinking? *Frontiers in Psychology*, *5*, 1–11. https://doi.org/10.3389/fpsyg.2014.01029.

Zaghi, A.E., Padgett, J.E., Bruneau, M., Barbato, M., Li, Y., Mitrani-Reiser, J., & McBride, A. (2016). Establishing common nomenclature, characterizing the problem, and identifying future opportunities in multihazard design. *Journal of Structural Engineering*, *142*, H2516001. https://doi.org/10.1061/(ASCE)ST.1943-541X.0001586.

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