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ORIGINAL ARTICLE

The Relationship Between Cognitive Distortions and Adult Attention-Deficit/Hyperactivity Disorder After Accounting for Comorbidities and Personality Traits

Amelia D. Serine[1] · Bradley Rosenfield[1] · Robert A. DiTomasso[1] · Jennifer M. Collins[2] · Anthony L. Rostain[3] · J. Russell Ramsay[3]

Abstract

Background This study examined the association between cognitive distortions and ADHD severity after accounting for depression, anxiety, and personality traits.

Methods Archival data were collected on 112 adult participants diagnosed with ADHD after an extensive assessment, which included inventories measuring mood, anxiety, and personality traits. Pearson correlations were used to assess the associations of ADHD and these comorbid variables. Regression analyses assessed the contribution of predictor comorbid variables to hypothesized associations with ADHD.

Results Results indicated that the relationship between cognitive distortions and ADHD symptom severity was no longer statistically significant once mood, anxiety, and personality traits were taken into consideration.

Conclusions These findings illuminate the complex role of cognitive distortions, comorbidities, and personality traits in the presentation of adult ADHD. As such, this study has clinical and conceptual relevance for understanding the role, candidate mechanisms, and therapeutic targets of cognitive-behavioral therapy for adult ADHD, particularly the cognitive component.

Keywords Attention-deficit/hyperactivity disorder (ADHD) · Adult ADHD · Cognitive distortions · Personality · Comorbidities · Cognitive-behavior therapy (CBT)

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is defined by the presence of pervasive and developmentally inappropriate inattentive and/or hyperactive-impulsive symptoms of number and severity that create impairment (*Diagnostic and Statistical Manual of Mental Disorders*, 5th ed. [*DSM-5*]; American Psychiatric Association [APA] 2013). ADHD is a neurodevelopmental disorder that is a lifelong syndrome for many individuals, including late identified adults. The individual and societal impact of ADHD is significant and wide-ranging. Negative effects of ADHD on daily life, social relationships, productivity, finances, and mental and physical health are well documented (Barkley and Fischer 2019; Faraone et al. 2015; Volkow and Swanson 2013), irrespective of cultural background or nationality. ADHD is a dimensional disorder with a continuum of symptom severity and impairments ranging from relatively mild cases with circumscribed difficulties to very severe, complex presentations with impairments that cut through multiple life domains.

Between 56 and 89% of individuals with ADHD will meet criteria for at least one additional psychiatric diagnosis in their lifetime (Barkley et al. 2008; McGough et al. 2005; Sobanski 2006). Though assessment of personality traits is not a standard procedure in most adult ADHD evaluations, personality disorders are the most prevalent comorbidity (50.7 to 78.5%; Cumyn et al. 2009; Jacob et al. 2007), followed by anxiety disorders (up to 47.1% comorbidity), and depressive disorders, (up to 50% comorbidity; see Barkley et al. 2008; Faraone et al. 2015; Kessler et al. 2006; Ramsay

✉ J. Russell Ramsay
ramsay@pennmedicine.upenn.edu

[1] Philadelphia College of Osteopathic Medicine, Philadelphia, PA, USA

[2] Penn Medicine Lancaster General Health, Lancaster, PA, USA

[3] University of Pennsylvania Perelman School of Medicine, 3535 Market St., 4th Floor, Philadelphia, PA 19104, USA

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et al. 2011; Sobanski 2006). As ADHD is a neurodevelopmental syndrome, many features of personality disorders and overall personality or temperament may overlap with ADHD (Ramsay and Rostain 2006), such as persistent, cross-situational avoidance, emotional dysregulation, and impulsivity.

Preliminary studies indicate that adult ADHD, both the diagnosis and positive symptom screening, is associated with more endorsement and higher severity ratings of early maladaptive schema (Miklósi et al. 2016; Philipsen et al. 2017), with schema reflecting more enduring belief systems commonly tied to personality disorders within the cognitive-behavior therapy (CBT) model (Beck et al. 2015). In a similar vein, studies have indicated that adults with ADHD endorse more maladaptive thoughts than non-clinical control groups (Abramovitch and Schweiger 2009; Biederman et al. 2006; Mitchell et al. 2013). Such maladaptive thoughts are typically referred to as cognitive distortions insofar as they represent misinterpretations (or at least skewing) of events that negatively affect emotions and functioning (Beck 1967). Recent studies of cognitive distortions in samples of adults with ADHD are shedding light on their effects on coping and functioning (Strohmeier et al. 2016; Torrente et al. 2014).

For example, cognitive distortions were found to be associated with depression and an avoidant coping style in a study of adults with ADHD (Knouse et al. 2013). Adults with ADHD and depression had higher ratings of cognitive distortions than adults with ADHD without depression, though the latter group had higher ratings of distortions than non-clinical controls (Mitchell et al. 2013). Similarly, there was a significant, positive correlation of cognitive distortions and ADHD when controlling for mood and anxiety in a clinical sample (Strohmeier et al. 2016). In addition to outlining the role of cognitive distortions in adult ADHD, these studies reflect the association of these cognitive patterns with symptom severity and comorbid factors.

To date, such studies of adult ADHD and cognitive distortions have not examined the role of personality. Personality disorders are highly associated with cognitive distortions (Beck et al. 2015) and are a common comorbidity in adult ADHD. Considering the growing literature on the role of cognitions in adult ADHD, an investigation of the potential connection of ADHD symptom severity, personality traits, other common comorbidities, and cognitive distortions could shed more light on the experience of adults with ADHD and inform clinical services.

The DSM-5 (APA 2013) includes an *Alternative DSM-5 Model for Personality Disorders*, to "address numerous shortcomings of the current approach to personality disorders" (p. 761). This model focuses on personality traits and functioning to increase the empirical bases for explaining distress and impairment, with traits thought to be more stable across time and settings than symptoms. An "extensively validated" model that was specifically cited within this proposed alternative approach (APA 2013) is the Five Factor Model of Personality (FFM; Costa and McCrae 1985), with the Revised NEO Personality Inventory (NEO-PI-R; Costa and McCrae 1992) providing a reliable measure of the FFM.

The FFM classifies personality into five factors or dimensional domains: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (Costa and McCrae 1985, 1992). Although not focused on personality disorders, per se, various FFM measures have been used in research on adult ADHD. Studies of the NEO-PI-R in samples of adults with ADHD have shown that the most common personality features are high Neuroticism, low Agreeableness, and low Conscientiousness (see Emilsson et al. 2020; Ramsay et al. 2011).

Research using FFM measures has yielded clinically useful information on personality traits relevant to adult ADHD that may contribute to clinical presentations but may or may not fulfill DSM-5 diagnostic criteria for a personality disorder (Parker et al. 2004; Stanton and Watson 2016; cf. Widiger and Costa 2013). For example, an examination of health-relevant FFM traits in a sample of adolescents with ADHD (13–17 years-old; Emilsson et al. 2020) indicated that high *negative affectivity* (the renaming of Neuroticism in the study) was associated with reduced treatment adherence as well as higher ratings of the need for medications, unpleasantness of side effects, and negative outlooks about prognosis of ADHD; high *impulsivity* (the opposite trait of Conscientiousness) was associated with high ratings of the negative consequences associated with ADHD and lower sense of personal control over them.

Consequently, based on existing studies of the FFM, adult ADHD, and the modified view of personality in DSM-5, the current study used the NEO-PI-R to measure the three FFM factors most associated with ADHD (Neuroticism, Agreeableness, Conscientiousness). Extreme scores on these three factors identified clinically-relevant personality traits.

The goal of this study was to assess the relationship between the severity of cognitive distortions and ADHD symptom severity in adults after accounting for comorbidities (anxiety symptoms [anxiety], depression symptoms [depression], and personality traits). First, it was hypothesized that the severity of ADHD would be correlated positively with Neuroticism, anxiety, and depression, and would be correlated negatively with Agreeableness and Conscientiousness. Second, it was predicted that the severity of ADHD, anxiety, depression, Neuroticism, Conscientious, and Agreeableness would predict an increased frequency of cognitive distortions. Third and finally, it was predicted that the relationship between the severity of ADHD and the frequency of cognitive distortions would remain predictive after accounting for the relative contribution of existing personality traits (high Neuroticism, low Agreeableness, and low Conscientiousness), depression, and anxiety.

Method

Participants

Archival data were reviewed on 112 adult participants who had completed an extensive assessment at an adult ADHD specialty clinic, located in a large university health system in the northeastern United States. The university's Institutional Review Board approved this chart review study. Participants included in the study were between the ages of 18 and 85, had symptoms meeting full criteria for an ADHD diagnosis, and completed all study measures. As per standard clinic procedures for new client evaluations, all individuals underwent extensive developmental interviews, clinician-administered interviews for both child and adult ADHD symptoms (the latter using the Structured Clinical Interview for DSM-5 [SCID-5; First et al. 2016] adult ADHD module), and completed self-report inventories on child and adult ADHD for both DSM-defined symptoms and normed scales for adult ADHD and related features.

Diagnoses were established by senior program clinicians or by advanced trainees (psychiatry residents, pre-doctoral student clinicians) supervised by senior clinicians. ADHD diagnoses were based on DSM criteria, including impairment, and ruling in or out clinical, medical, and other factors. Individuals displaying symptoms not consistent with ADHD or reflecting other conditions warranting referral, such as active substance dependence, were referred to appropriate care and were not included in this study.

Measures

Inventory of Cognitive Distortions (ICD)

The ICD is a 69-item self-report measure of 11 cognitive distortions (Yurica and DiTomasso 2002) rated on a five-point Likert scale. A higher score reflects a greater magnitude of endorsed cognitive distortions. The ICD demonstrated excellent internal consistency (Cronbach's $\alpha = .98$) and test–retest reliability ($r = .998$) in an adult clinical sample (Yurica 2002). The ICD also demonstrated excellent construct and content validity, per 100% expert agreement on the descriptions of its targeted cognitive distortions. Strong concurrent and construct validity were also established for the ICD, as it had strong positive correlations with the Dysfunctional Attitude Scale ($r = .70$; Weissman and Beck 1978), the Beck Anxiety Inventory ($r = .59$; Beck and Steer 1990), and the BDI-II ($r = .70$; Beck et al. 1996).

The ICD was used in this study because it is a measure of cognitive distortions consistent with the CBT approach. It was studied in a sample of adults with ADHD and was positively correlated with ADHD symptoms (controlling for depression and anxiety; Strohmeier et al. 2016). A cognition scale specifically designed for adults with ADHD (Knouse et al. 2019) was not available at the time of this study.

Revised NEO Personality Inventory (NEO-PI-R)

The NEO-PI-R is a 240-item measure of the five personality domains of the FFM: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. The validity and reliability of the NEO-PI-R were reported to be excellent (Costa and McCrae 1992).

Brown Attention Deficit Disorder Scale-Adult Version (BADDS)

The BADDS is a 40-item self-report measure of core features of ADHD in adults (Brown 1996) that provided a symptom severity measure for participants diagnosed with ADHD. T-scores of 65 or above are used to define clinical elevation, with higher scores suggesting higher probability of diagnosis. Items on this scale are clustered around five main domains of ADHD, drawing on Brown's executive dysfunction model of ADHD: (a) ability to sustain attention and concentration, (b) ability to sustain energy and effort, (c) organization and activation for work, (d) managing affective interference, and (e) using working memory and accessing recall (Brown 1996). A psychometric evaluation of the BADDS demonstrated excellent internal consistency (Cronbach's $\alpha = .96$) and sufficient test–retest reliability ($r = .87$; Brown and Whiteside 2003). The BADDS has been updated as the Brown Executive Function/Attention Scales (Brown 2019) that was not available at the time of this study.

Beck Depression Inventory, Second Edition (BDI-II).

The BDI-II is a 21-item self-report scale of depression (Beck et al. 1996). Higher scores indicate greater perceived depression. The BDI-II has demonstrated high internal consistency (Cronbach's $\alpha = .91$) and test–retest reliability ($r = .93$; Beck et al. 1996a, b).

Penn State Worry Questionnaire (PSWQ)

The PSWQ is a 16-item self-report measure of the severity and frequency of worry (Meyer et al. 1990). An overall worry score is calculated with higher scores indicating greater perceived worry. The PSWQ is relevant for adult ADHD, as worry more than state anxiety is closely related to distractibility (Lapointe et al. 2013). The PSWQ has demonstrated strong internal consistency (Cronbach's $\alpha = .83$–$.93$)

and test–retest reliability ($r = .74–.93$) (Brown et al. 1992; Molina and Borkovec 1994).

Procedure

The present study used relevant archival clinical data collected at the specialty clinic between 2014 and 2016. The data were de-identified and exported into SPSS 22.0 for analysis.

Results

Demographics

The sample consisted of 77 males and 35 females, with a mean age of 32 (range of 18 to 60). Participants identified as 75% Caucasian, 4.5% Hispanic, 3.5% "Other," 2.7% African American, 1.8% Asian American, and 12.5% unspecified.

Statistical Analyses

Power analyses were performed for both a Pearson product-moment correlation and for multiple regression with six predictors (Cohen 1988, 1992). Significance levels were set at 0.05, power levels at 0.80, and medium effect sizes were set at 0.30 for the correlation and 0.15 for the multiple regression, as per conventional standards (Cohen 1988, 1992). The required number of participant charts needed to perform the multiple regression analysis was determined to be 110.

Hypothesis I

To examine whether the severity of ADHD was significantly positively correlated with Neuroticism, anxiety, and depression, and significantly negatively correlated with Agreeableness and Conscientiousness, six Pearson product-moment correlations were conducted. To control for the increased likelihood of a Type 1 error, a Bonferroni correction was calculated to set a more stringent alpha level of .008. Results indicated a significant positive relationship between ADHD and both Neuroticism ($r = .295$, $p = .002$) and depression ($r = .410$, $p = .000$). Results also indicated a significant negative relationship between ADHD and Conscientiousness ($r = -.566$, $p = .000$). The relationship between ADHD and anxiety approached significance ($r = .215$, $p = .023$), but was not significant when using the alpha level of .008. There was no significant relationship between ADHD and Agreeableness ($r = -.111$, $p = .245$). Correlations, means, and standard deviations are reported in Table 1.

Hypothesis II

To determine whether the severity of ADHD, anxiety, depression, and Neuroticism, as well as Agreeableness and Conscientiousness significantly predicted frequency of cognitive distortions, a multiple regression was conducted. All tests of assumptions of multiple linear regression were met and there was no evidence of multicollinearity. The assumptions of linearity and homoscedasticity also were met, as were the assumptions of normality and absence of autocorrelation of the residuals.

After removing a single outlier score (more than 3 standard deviations from the mean), the results of the multiple linear regression analysis revealed a multiple correlation of $R = .720$ with a coefficient of determination of .519 ($R^2 = .519$), indicating that 51.9% of the variance observed can be attributed to this combination of predictor variables.

The adjusted coefficient of determination ($AdjR^2 = .491$) suggests there would be some shrinkage from sample to population if the population had been evaluated. The overall regression analysis revealed a significant regression ($F[6, 110] = 18.673$, $p = .000$), indicating the predictors made a significant collective contribution to the prediction of cognitive distortions.

As shown in Table 2, an examination of each of the predictor variables revealed that only three of the predictors (depression, anxiety, and Neuroticism) made a significant, positive contribution to the prediction of severity of distorted thinking.

Table 1 Correlations, means, and standard deviations for ADHD, neuroticism, anxiety, depression, agreeableness, and conscientiousness

	ADHD	Neuroticism	Anxiety	Depression	Agreeableness	Conscientiousness	*M*	*SD*
ADHD	–	.295*	.215	.410*	−.111	−.566*	76.48	10.37
Neuroticism	.295*	–	.542*	.586*	−.045	.133	59.36	12.81
Anxiety	.215	.542*	–	.439*	−.091	.126	52.45	16.20
Depression	.410*	.586*	.439*	–	−.013	−.074	16.27	10.51
Agreeableness	−.111	−.045	−.091	−.013	–	−.139	48.24	13.66
Conscienti-ousness	−.566*	.133	.126	−.074	−.139	–	34.95	14.63

*$p < .008$

Table 2 Coefficients of predictor variables (conscientiousness, depression, agreeableness, anxiety, neuroticism, and ADHD) to the dependent variable (cognitive distortions)

Model	Unstandardized coefficients		Standardized coefficients	t	Sig	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (constant)	− .089	38.437		− .002	.998		
ADHD	.519	.401	.129	1.295	.198	.469	2.130
Anxiety	.593	.224	.223	2.646	.009	.653	1.531
Depression	1.336	.335	.335	3.712	.000	.567	1.764
Neuroticism	.720	.311	.221	2.319	.022	.510	1.962
Agreeableness	− .237	.217	− .077	− 1.092	.277	.923	1.084
Conscientiousness	.053	.273	.018	.195	.846	.540	1.851

Hypothesis III

A hierarchical multiple regression was conducted to evaluate whether the severity of ADHD was predictive of frequency of cognitive distortions, after accounting for the relative contribution of existing personality traits, depression, and anxiety. In this analysis, Neuroticism, Agreeableness, Conscientiousness, depression, and anxiety were accounted for in the first level; ADHD was accounted for in the second level. The assumptions of the analysis were met for linearity, homoscedasticity, and normality. There was also no evidence of multicollinearity or autocorrelation of the residuals.

The Multiple R^2 was found to be .715 with a coefficient of determination of .511 and minimal shrinkage shown with an adjusted coefficient of determination ($R^2 = .488$). The F change was highly significant at the .000 level. In Model 2, which included only the ADHD severity score after having controlled for the others, the F change was insignificant. The combination of variables led to a significant prediction wherein Neuroticism, depression, and anxiety made a significant contribution to cognitive distortion scores.

Model 2 was significant. Once again it was Neuroticism, depression, and anxiety that made a significant contribution to the prediction (see Table 3). ADHD severity did not make a significant contribution to cognitive distortion scores.

In a subsequent analysis, another outlier was removed and the analysis revealed virtually the same results. After all assumptions were met, the Multiple R^2 was found to be .736 with a coefficient of determination of .542 and minimal shrinkage shown with an adjusted coefficient of determination ($R^2 = .520$). The F change was highly significant at the .000 level. As in the previous analysis, Model 2 also had an F change that was insignificant. Again, the severity of ADHD did not make a significant contribution and, instead, it was Neuroticism, depression, and anxiety that made significant contributions to the criterion of cognitive distortions (see Table 4).

Table 3 Coefficients of predictor variables to the dependent variable from Model 1 and Model 2

Model	Unstandardized coefficients		Standardized coefficients	t	Sig	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (constant)	43.054	19.220		2.240	.027		
Neuroticism	.810	.304	.249	2.668	.009	.537	1.863
Agreeableness	− .306	.211	− .100	− 1.448	.151	.981	1.019
Conscientiousness	− .178	.208	− .060	− .856	.394	.941	1.062
Depression	1.450	.350	.364	4.140	.000	.603	1.659
Anxiety	.608	.224	.228	2.707	.008	.655	1.527
2 (constant)	− .089	38.437		− .002	.998		
Neuroticism	.720	.311	.221	2.319	.022	.510	1.962
Agreeableness	− .237	.217	− .077	− 1.092	.277	.923	1.084
Conscientiousness	.053	.273	.018	.195	.846	.540	1.851
Depression	1.336	.360	.335	3.712	.000	.567	1.764
Anxiety	.593	.224	.223	2.646	.009	.653	1.531
ADHD	.519	.401	.129	1.295	.198	.469	2.130

Note Dependent variable is cognitive distortions

Table 4 Coefficients of predictor variables to the dependent variable from Model 1 and Model 2

Model	Unstandardized coefficients		Standardized Coefficients	t	Sig	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (constant)	36.879	18.451		1.999	.048		
Neuroticism	.806	.290	.252	2.779	.006	.538	1.859
Agreeableness	− .243	.203	− .080	− 1.196	.234	.978	1.022
Conscientiousness	− .090	.200	− .031	− .452	.652	.939	1.065
Depression	1.503	.335	.384	4.489	.000	.603	1.658
Anxiety	.613	.214	.234	2.860	.005	.656	1.525
2 (constant)	− 3.776	36.735		− .103	.918		
Neuroticism	.721	.297	.225	2.431	.017	.511	1.957
Agreeableness	− .178	.208	− .059	− .855	.394	.921	1.086
Conscientiousness	.127	.262	.043	.483	.630	.544	1.838
Depression	1.396	.344	.356	4.053	.000	.567	1.764
Anxiety	.599	.214	.229	2.799	.006	.654	1.529
ADHD	.490	.383	.123	1.279	.204	.472	2.118

Note Dependent variable is cognitive distortions.

Discussion

Severity of ADHD and Comorbidities

The results of the current study indicate that ADHD severity was highly and positively correlated with Neuroticism, a personality trait associated with other psychiatric disorders, including personality disorders, anxiety and depression (Widiger and Costa 2013). ADHD severity also correlated positively with depression but negatively with Conscientiousness. The association of ADHD severity, depression, and personality factors is consistent with previous studies (Jacob et al. 2007; Parker et al. 2004), inasmuch as when emotional and personality traits co-occur with ADHD in adults, ADHD symptomatology is more severe. Conversely, individuals with more severe ADHD are more likely to present with more complex comorbidities. Likely owing to the fact that ADHD is a neurodevelopmental syndrome and, therefore, has some overlap with personality development and expression (Ramsay and Rostain 2006), low Conscientiousness and high Neuroticism could be viewed as consistent with executive dysfunction and its role in poor follow through and emotional dyscontrol, respectively, which are characteristic of ADHD in adults (Adler et al. 2017).

What diverged from previous studies is that the relationship of ADHD severity and anxiety was not statistically significant in this study. There also was no relationship between ADHD severity and Agreeableness. The association of ADHD severity and Agreeableness has been equivocal in past studies (Gomez and Corr 2014; Jacob et al. 2007; Miller et al. 2008; Nigg et al. 2002; Parker et al. 2004). However, the current study did not examine whether ADHD presentation type affects the relationship with Agreeableness, as these data were not available.

The Role of Cognitive Distortions in Adult ADHD:

Results of this study indicated that the overall combination of ADHD severity, increased anxiety, depression, and Neuroticism, and decreased Conscientious and Agreeableness significantly predicted frequency of cognitive distortions. The three variables that contributed most significantly to the prediction of cognitive distortions were depression, Neuroticism, and anxiety (though when using a more stringent threshold, anxiety was no longer significant). These results are consistent with past findings that depression (Mathews and MacLeod 2005; Yurica 2002) and Neuroticism (Vasey and MacLeod 2001) are strongly correlated with cognitive distortions in clinical populations without ADHD.

For clinical practice, these results underscore the importance of a thorough pre-treatment assessment of adult ADHD to identify the relevant clinical complexities, particular in more severely symptomatic cases. The presence of anxiety, depression, and/or Neuroticism is associated with clinically significant cognitive distortions. These distortions likely exacerbate the common functional difficulties of ADHD and concurrently interfere with the use of recommended coping strategies. This creates a vicious cycle that can be broken by adapting treatment to target the maladaptive thoughts tied to these comorbid features, which are part of the full clinical picture of adult ADHD.

For example, Widiger and Costa (2013) posit that high Neuroticism plays a role in nearly all personality disorders. The ego-dystonic nature of high Neuroticism and efforts by adults with ADHD to reduce emotional distress is consistent

with their escape-avoidance coping style (Knouse et al. 2013, 2019; Torrente et al. 2014; Ramsay 2020). Emotional regulation strategies, such as emotional labeling and acceptance of emotional discomfort can be used in service of therapeutic change (Ramsay 2020; Rosenfield et al. 2008).

The statistical disconnect between ADHD severity, on the one hand, and comorbidities and cognitive distortions, on the other, does not mean that comorbidities are modular facets that are clinically distinct from the phenomenology of adult ADHD. The risk here is that such a narrow interpretation of the data gives rise to a take-away assumption that the cognitive domain of CBT for adult ADHD can be managed by standard means for targeting cognitive distortions, depression, anxiety, and personality disorders. Such therapeutic approaches will at best be only partially helpful if interventions and overall case conceptualization are not adapted and personalized to address the clinical features of complex ADHD and their effects on cognitions, which interfere with standard interventions that fail to address deficits in executive functioning.

A richer, developmentally sophisticated formulation of the complexities of adult ADHD will include the contemporary neurodevelopmental model of ADHD as a disorder of executive dysfunction and self-dysregulation (Antshel et al. 2014; Brown 2013), with comorbidities, personality, and cognitive distortions also viewed through this lens. That is, cognitive distortions have never been viewed as playing an etiologic role in the core symptoms or executive function deficits associated with ADHD (Ramsay 2017, 2020; Ramsay and Rostain 2015). Instead, the conceptual pathway, as framed in CBT models for adult ADHD, is that individuals with ADHD are vulnerable to persistent distress and impairment from the core deficits, which, in turn, increase the risk of growing frustrations and failure experiences that coalesce into negative attitudes and beliefs. These cognitive factors magnify impairments through cognitive-behavioral avoidance, which reinforce cognitive biases that contribute to co-existing dysfunction, as well as emotional symptoms (Knouse et al. 2013; Ramsay 2020; Ramsay and Rostain 2015; Safren et al. 2017; Solanto 2011; Young and Bramham 2012).

Indeed, a longitudinal study of college students with ADHD tracked through an academic year examined the pathways outlined in the cognitive-behavioral model of adult ADHD (Eddy et al. 2015). The results indicated that negative self-concept and depression fully mediated the association between previous academic functioning and self-report of overall functioning at follow-up. Negative self-concept was seen as an important precursor to depression, which stemmed from the experience of living with ADHD.

This framework sees ADHD (and its continuum of severity) as the engine driving the co-existing factors, consistent with the findings of the current, albeit cross-sectional study. Mood and personality traits can be viewed as interacting effects of living with ADHD and not unrelated vectors. A developmental psychopathology model of ADHD and its common comorbidities in children and teens (anxiety, depression, and oppositionality) posits that emotional regulation is a shared risk process that reciprocally interacts with temperament and context to shape the expression of these common comorbidity patterns (Steinberg and Drabick 2015). In fact, recent findings suggest that presence or absence of emotional dysregulation identifies clinically relevant ADHD subtypes (Reimherr et al. 2020). Similarly, low hedonic tone and its effects on reward processing has been found to be a shared characteristic among those at risk for ADHD, depression, and substance use, which helps explain the common co-occurrence of these disorders (Sternat and Katzman 2016).

Regarding intervention, among adults with ADHD, a more extensive treatment history for ADHD, lower endorsement of ruminative thinking patterns, and reduced cognitive-behavioral avoidance emerged as protective factors promoting resiliency to an ADHD-depression comorbidity (Oddo et al. 2016). This framework moves from seeing clinical presentations, at least in terms of a developmental syndrome such as ADHD, as different silos of comorbidities to viewing more complex phenomenological trajectories with interrelated clinical features. This view requires more individualized treatment within a broader understanding of ADHD, such as adapted case conceptualizations accounting for the aforementioned issues, including cognitive distortions and schema (see Dittner et al. 2018; Lücke et al. 2017).

CBT is already considered an evidence-supported treatment for adult ADHD (Society of Clinical Psychology Division 12 of the American Psychological Association: https://www.div12.org/treatment/cognitive-behavioral-therapy-for-adult-adhd/). CBT is often a facet of combination treatments for adult ADHD that include medication, particularly for adults manifesting more severe and complex presentations. There are effective broad- and narrow-band treatments available (Faraone and Antshel 2014), the former targeting the core symptoms of ADHD to improve overall functioning, such as pharmacotherapy; the latter focused on targeted areas of impairment to improve functioning in those domains, such as CBT for adult ADHD. The awareness of the role of cognitions can be used to hone cognitive interventions to promote consistent implementation of essential coping skills (Ramsay 2020; Ramsay and Rostain 2015).

Limitations

A notable limitation to the current study is the use of the NEO-PI-R to assess personality traits, as it was not designed to diagnose personality disorders. Although different NEO-PI-R profiles are representative of various personality

disorders (Saulsman and Page 2004), the conclusions of the current study should be interpreted with caution when generalizing results to adults with both ADHD and personality disorders. Even so, temperament and personality traits are clinically relevant, as they may influence how interventions are couched and prioritized (see Emilsson et al. 2020; Robin et al. 2008).

A second limitation is that the sample consisted of adults with ADHD who, on average, were of higher socioeconomic status and better functioning than typically seen in community care. It is also possible that there is an inherent bias in the current sample, given that it was composed of patients seeking help from a specialty clinic that only accepts private pay or university-based healthcare versus community care. The sample consisted largely of White males, which also limits generalizations to women, non-binary or transgender individuals (see Wanta et al. 2019), and other underrepresented groups living with ADHD.

A third limitation in this study is the use of archival data. Detailed data were not available for medication status, ADHD presentation, and comorbidity profile beyond the scores reported in the study. There may have been different results across variables between those who were medicated or not, or between Combined or Predominantly Inattentive Presentation. Amongst the scales used in the current study, the mean score for depression (BDI-II) fell in the mild range and for anxiety (PSWQ) fell in the moderate range. By themselves, these scores do not necessarily reflect evidence of depressive or anxiety disorders in all cases. Personality traits were drawn from extreme measures on specified NEO-PI-R factors consistent with ADHD. These factors may reflect distress associated with living with ADHD rather than distinct diagnoses.

A final limitation is the use of self-report measures. Although such scales are reliable and common to clinical practice, young adults with ADHD may underreport symptoms (Barkley et al. 2008). Such underreporting might affect the identification of ADHD and thereby our results. The multi-faceted evaluation in this study drew clinical data from diverse sources, such as structured interview and observer reports, thus increasing diagnostic confidence.

Future Directions

The current results provide a different avenue of exploration of the role of cognitive distortions in adult ADHD and its common comorbidities. It will be important for the current findings to be replicated and expanded, including the use of mediational models to explore such clinical complexities. Community samples of adults with ADHD would be more representative of the wider adult ADHD population. A measure of cognitive distortions designed for adult ADHD has been published (Knouse et al. 2019) that can provide more nuanced assessments of the cognitions of clinic-referred adults with ADHD.

Similarly, many cognitive processes and distortions will be similar across different clinical populations, though their manifestation may differ. For example, the finding that perfectionism was the most frequently endorsed cognitive distortion in a sample of adults with ADHD was conjectured to reflect "front-end" perfectionism or having circumstances be "just right" before starting a task, which would promote procrastination (Ramsay 2017; Strohmeier et al. 2016). Thus, the use of a traditional measure of distortions is more likely to have strong associations with mood and anxiety. Nevertheless, existing measures of cognitive distortions can be re-examined to determine if there are unique cognitive profiles that help guide understanding and intervention, including possible variations with different comorbidity profiles, akin to the cognitive specificity seen in other disorders (Ramsay 2020).

In sum, these findings contribute to the research on cognitive distortions in adult ADHD by including personality traits alongside the typical comorbid factors associated with adult ADHD. These considerations have implications for psychosocial treatment for adult ADHD.

Compliance with Ethical Standards

Conflict of interest Amelia D. Serine, Bradley Rosenfield, Robert A. DiTomasso, Jennifer M. Collins, Anthony L. Rostain, and J. Russell Ramsay declare that they have no conflict of interest.

Research Involving Human and Animal Participants The current study was based on a chart review study that was approved by the authors' respective Institutional Review Boards (IRB). No animal studies were conducted in this study.

Informed Consent As the study was a chart review of archival clinical records, the collection of informed consent was waived by the IRBs.

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