Do personality traits explain the association between childhood attention-deficit hyperactivity disorder symptoms and substance use and problems in young adults?

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Abstract

Childhood attention-deficit/hyperactivity disorder (ADHD) is associated with increased risk of substance-related problems in adulthood. While comorbid disorders have been hypothesized to account for this risk, the role of personality factors has not yet been examined, despite findings of robust associations between temperament and personality traits and both ADHD and substance use problems. 349 young adults ages 18–38 years (M = 23.22 years, SD = 4.79, 54.7% male) completed a multi-informant assessment protocol, including self and informant retrospective measures of childhood ADHD symptoms, self-report measures of personality traits (NEO-FFM), and ratings of substance use and related problems. A multiple mediational framework was used to examine whether personality traits explained the association between childhood ADHD symptoms and substance use and problems in adulthood. Results revealed that childhood hyperactivity–impulsivity, but not inattention, directly influenced substance use and problems in adulthood. However, several indirect effects involving personality traits also emerged. Neuroticism and agreeableness appeared to be more relevant for explaining links between childhood ADHD symptom dimensions and substance-related problems, whereas conscientiousness and openness appeared to explain associations between childhood ADHD symptom dimensions and substance use. Overall, findings highlight the importance of personality traits for understanding the overlap among disorders on the externalizing spectrum.

Keywords: Attention-deficit hyperactivity disorder Substance use Substance problems Personality Mediation

1. Introduction

1.1. Heterotypic comorbidity among ADHD and substance-use disorders

Childhood attention-deficit hyperactivity disorder (ADHD) has been associated with substance-use disorders (SUDs) in both adolescents (Groenman et al., 2013) and adults (Kessler et al., 2006). Importantly, recent meta-analytic work has demonstrated a moderate longitudinal association between childhood ADHD and the subsequent development of SUDs that remains when controlling for comorbid externalizing behaviors (Lee, Humphreys, Flory, Liu, & Glass, 2011). However, several diverse mechanisms may account for these patterns of heterotypic comorbidity. Some prior work has indicated that childhood ADHD may predict an earlier onset of substance use, which then increases the risk of developing problems of abuse and dependence, via an accelerated gateway model (Dunne, Hearn, Rose, & Latimer, 2014). Within this model, it becomes crucial to differentiate between substance use (i.e., intake) and substance problems (i.e., symptoms of abuse and physical and psychological dependence associated with use), as not all individuals who use substances go on to develop problems (Stone, Becker, Huber, & Catalano, 2012) and evidence that use and problems may have different etiologic determinants (Kendler, Jacobson, Prescott, & Neale, 2003).

Further, there is substantial heterogeneity in the development of substance-related disorders among adults with ADHD (Farasone et al., 2007), leading to questions regarding the processes that influence the development of their comorbidity. Personality traits have been proposed as one such influence, based on measurement models suggesting common variance contributes both to personality and psychopathology (Krueger, Markon, Benning, & Kramer, 2007). Several theoretical models have been advanced to better understand this common variance, including pathoplastic models (i.e., personality and psychopathology have mutually reciprocal influences), causal models (i.e., personality causally contributes to psychopathology), and spectrum models (i.e., psychopathology as an extreme variation of normal personality functioning, see Widiger, 2011 for review).

For the purposes of the current study, we adopt a causal model, hypothesizing that personality factors play a role in the heterotypic comorbidity between childhood ADHD and substance use and problems in adulthood. Past work has indicated that personality traits may be useful for understanding the causes of heterotypic comorbidity (Beachaine & McNulty, 2013; Lilienfeld, 2003), and studies have demonstrated that
personality may influence trajectories of psychopathology development (Chassin, Flora, & King, 2004).

1.2. Personality trait differences among individuals with SUDs and ADHD

Past work has shown robust associations between personality traits and substance-related problems. While several models of personality are relevant, we focus on the Five-Factor Model (McCrae & John, 1992), given that the majority of past work has emphasized its trait domains and facets. Findings indicate that individuals with SUDs tend to display higher mean levels of neuroticism and lower mean levels of conscientiousness and agreeableness compared to individuals without SUDs (Terracciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008). Similarly, low conscientiousness and high neuroticism appear to be associated with adult ADHD and co-occurring externalizing problems (Avisar & Shalev, 2011). However, associations appear to vary across ADHD symptom dimensions, which while correlated, are also separable and differentially associated with impairments and outcome (Willcutt et al., 2012). For example, inattention has been specifically linked with low conscientiousness and neuroticism, whereas hyperactivity–impulsivity has been specifically linked with low agreeableness and low reactive control (Martel & Nigg, 2006; Ullsperger, Nigg, & Nikolas, 2015).

1.3. A mediational framework

Given this past work, tests of mediation may prove to be particularly useful for determining if personality traits play a role in the development of substance use and problems among youth with ADHD. A multiple mediation framework may be especially relevant for examining such processes (Preacher & Hayes, 2008), as this approach provides tests of mediation while considering the joint and individual impact of several mediators simultaneously, while also taking into account the potential inter-correlations among mediators. Further, this framework is in line with theoretical advances in the conceptualization and execution of mediation models, which are no longer reliant on prior establishment of direct effects and can provide simultaneous tests of all effects in the pathway (Hayes, 2013).

1.4. Current research

The purpose of the current study was to examine personality traits as mediators of the association between childhood ADHD symptoms and substance use and problems in young adulthood, and thus, the potential causal role of personality traits in the heterogeneous comorbidity among externalizing dimensions. Further, we elected to examine both substance use and problems as outcomes, given recent revisions to the DSM-5 diagnostic criteria that include abuse and dependence together as problems (Hasin et al., 2013), the distinction between use and problems in the accelerated gateway model, and evidence pointing toward differentiation in risk factors for use versus problems (Sloboda, Glantz, & Tarter, 2012).

Overall, we predicted that childhood inattention and hyperactivity–impulsivity would statistically predict substance use and problems via their association with personality traits, as indexed via the sum of indirect effects in the mediation models. Further, we also predicted that certain traits would show specific indirect effects in these models. Based on recent meta-analytic work (Kotov, Gamez, Schmidt, & Watson, 2010), we predicted that specific indirect effects involving agreeableness and conscientiousness would account for the association between childhood ADHD symptoms and substance-related problems in adulthood. Similarly, we also predicted that specific indirect effects involving neuroticism would explain the association between childhood ADHD symptoms and both substance use and problems.

2. Methods

2.1. Participants

Participants were 349 adults ages 18–38 years ($M = 23.2, SD = 4.5, 54.7\%$ male). Participants were recruited via advertisements in local newspapers, email listservs, and at local clinics in order to obtain a representative sample as possible, while avoiding the biases of relying on a purely clinical-referred group. Participants with a confirmed or suspected diagnosis of ADHD as well as those without ADHD were invited to participate in a study of the condition among young adults. Participants were primarily Caucasian (87.1\%), with smaller proportions of African–American (2.6\%), Latino (3.2\%), Asian (2.3\%), and multi-ethnic participants (3.4\%), which are comparable to the surrounding area.

2.2. Diagnostic procedures

Each participant completed a three-hour laboratory visit, which included administration of a diagnostic interview to assess current and lifetime symptoms of ADHD (based upon Kessler et al., 2005). The interview included all 18 DSM-5 ADHD symptoms (with DSM-5 adult-specific wording) and asked for current as well as childhood exemplars of each symptom. Participants also completed ratings of current and childhood ADHD symptoms, a battery of neuropsychological tests (see Kamradt, Ullsperger, & Nikolas, 2014 for more details), as well as ratings of substance use and problems (see below). Additionally, participants provided contact information for 2 individuals to serve as informants (e.g., parents, roommates, friends, romantic partners, employers). These individuals also completed ratings of ADHD symptoms, executive function, and impairment about the participant. 72.5\% ($n = 253$) of the participants had reports from at least one informant.

Final diagnostic status was determined by the principal investigator (MAN), who reviewed all self and informant report data from questionnaires and responses and examples provided on the diagnostic interview to determine final DSM-5 diagnoses. An overall symptom count for both current and childhood ADHD symptoms was calculated by applying an “or” algorithm to self and informant data. Additionally, scores of current and childhood functional impairment from the diagnostic interview and questionnaire measures, cross-situational presence of symptoms, and onset of symptoms before age 12 was determined for each participant in line with DSM-5 criteria. Both a childhood and current diagnostic presentation type were assigned based upon appropriate symptom thresholds specified in DSM-5 (6 for childhood, 5 for present functioning).

The final sample was comprised of 217 adults with ADHD (met diagnostic criteria during childhood only or during childhood and currently) and 114 non-ADHD adults. 29.5\% of the sample reported taking prescribed stimulant medications currently (45.2\% of the ADHD group), similar to past reports of medication use within community samples (Jensen, Martin, & Cantwell, 1997). 18 adults presented with subthreshold or situational ADHD symptoms — these individuals were excluded from analyses examining group differences, but retained in mediational analyses.

2.2.1. Exclusion criteria

Participants were excluded if they were not fluent in English or a native English speaker. Participants were also required to have normal or corrected-to-normal vision and hearing. Participants with a history of Tourette’s disorder, schizophrenia, psychosis, or autism spectrum disorder were also excluded.
2.3. Measures

2.3.1. Current and childhood ADHD symptoms

ADHD symptom dimension scores were derived from self and informant-report on the Barkley Adult ADHD Rating Scale-IV (BAARS-IV Current and Childhood versions; Barkley, 2011). Current and childhood inattentive and hyperactive–impulsive symptoms were rated on a 1–4 Likert scale (never, sometimes, often, and very often). Total scores for each dimension were computed by summing the relevant items. Reliability and validity of the BAARS-IV has been established (Barkley, 2011). Internal consistencies for all the BAARS-IV scales in the current sample were adequate (all α > .91). We emphasized childhood reports in the mediation models to account for the temporal ordering of variables. Self and informant reports of childhood ADHD symptom dimensions were significantly correlated for both inattention (r = .56, p < .001) and hyperactivity–impulsivity (r = .55, p < .001). Therefore, we created mean composite sum scores for both dimensions by averaging self and informant raw scores. Scores were Blom-transformed and standardized prior to analyses to alleviate positive skew (skew following transformation < .09). These mean composites were retained for all subsequent analyses.

2.3.2. Substance use and problems

The 160-item version of the Externalizing Spectrum Inventory (Venables & Patrick, 2012) was administered to participants in order to evaluate their use of alcohol, marijuana, and other drugs, as well as their substance-related problems. Internal consistencies for these subscales were adequate: alcohol problems (α = .83), alcohol use (α = .86), drug problems (α = .83), drug use (α = .79), marijuana problems (α = .83), and marijuana use (α = .92). Scores were Blom-transformed and standardized prior to analyses to alleviate positive skew (skew following transformation < .10).

2.3.3. Personality traits

Participants completed the NEO Five-Factor Inventory-3 (McCrae & Costa, 2010) in order to scale their personality in accordance with the Big Five Personality Traits. Participants responded to 60 statements on a 5-point Likert scale response system (ranging from strongly disagree to strongly agree). All five-trait domain scales showed adequate internal consistency: neuroticism (α = .86), extraversion (α = .85), openness (α = .79), agreeableness (α = .79), and conscientiousness (α = .89). Due to the strong overlap between conscientiousness and BAARS-IV ADHD items, six out of twelve conscientiousness items were removed in order to minimize any artificial correlation between these scales (modified scale α = .79) in line with prior work (Martel & Nigg, 2006; Ullsperger et al., 2015). Personality trait dimensions did not show evidence of skewness or kurtosis within the current sample, and thus, were standardized prior to analyses.

2.4. Data analysis

Missing data were minimal in the current study (<5.3% on all measures). Therefore, full maximum-likelihood estimation, a method of directly fitting models to raw data, was used without imputing values. Group differences in variables and computation of descriptive statistics were first examined using t-tests and chi-square tests. Next, multiple mediation analyses were conducted in Mplus version 7.0 (Muthén & Muthén, 1998-2013). Both direct and indirect effects of childhood ADHD symptom dimension scores on substance-use and substance-related problem variables were estimated using bootstrapped standard errors (Preacher & Hayes, 2008). In order to gauge the specific and combined mediational effects of personality traits on the relationship between ADHD symptoms and substance use and problems, all five-personality traits were simultaneously examined as mediators in the models. Age, gender, ethnicity, and income were included as covariates. Further, ADHD symptom dimensions of inattention and hyperactivity–impulsivity were examined as predictors in separate models to determine specificity of associations, based on prior work supporting the validity of a multi-dimensional conceptualization of ADHD (Marcus & Barry, 2011; Willcutt et al., 2012).

3. Results

3.1. Demographic and descriptive statistics

Demographic and descriptive statistics are presented in Table 1. Diagnostic procedures appeared to successfully distinguished adults with and without ADHD. Ratings of neuroticism and openness were significantly higher among those with ADHD relative to controls, yet, as expected; ratings of conscientiousness were significantly lower among ADHD adults compared to their non-ADHD counterparts. As expected, ratings of alcohol problems, drug problems, drug use, marijuana problems, and marijuana use were all significantly higher among ADHD adults relative to non-ADHD adults, consistent with past work (Lee et al., 2011).

3.2. Mediation analyses

3.2.1. Alcohol use and problems

Direct effects between childhood inattention and alcohol use and childhood hyperactivity–impulsivity and alcohol use were not significant (ps = .10). However, both inattention (β = .08, [.03, .14], p = .02) and hyperactivity–impulsivity (β = .08, [.03, .13], p = .009) exerted significant indirect effects on alcohol use as indexed by the sum of the indirect effects. However, none of the specific indirect pathways were statistically significant, although conscientiousness was a marginally significant mediator between inattention and alcohol use (β = .04, [.003, .08], p = .08), whereas agreeableness was a marginally significant mediator between hyperactivity–impulsivity and alcohol use (β = .02, [.001, .01], p = .08, see Fig. 1).

Childhood hyperactivity–impulsivity, but not inattention, directly predicted alcohol problems (β = .11, [.01, .21], p = .05). Both inattention (β = .13, [.08, .19], p < .001) and hyperactivity–impulsivity (β = .14,. [09, .19], p < .001) indirectly predicted alcohol problems. Examination of the point estimates of the specific indirect effects revealed that the association between inattention and alcohol problems was statistically mediated by both neuroticism (β = .07, [.03, .11], p = .003) and agreeableness (β = .03, [.01, .05], p = .05), that increased

Table 1

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Demographic and descriptive statistics.</th>
</tr>
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<tr>
<td></td>
<td>Control</td>
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<tr>
<td>N</td>
<td>114</td>
</tr>
<tr>
<td>% Male</td>
<td>50.0%</td>
</tr>
<tr>
<td>Age (SD)</td>
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</tr>
<tr>
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<td>88.6%</td>
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<tr>
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<tr>
<td>Hyperactivity Sx (SD)</td>
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<tr>
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<tr>
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<td>1.3 (1.6)</td>
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<tr>
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<td>Alcohol problems (SD)</td>
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<td>Alcohol use (SD)</td>
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<tr>
<td>Drug problems (SD)</td>
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<tr>
<td>Marijuana problems (SD)</td>
<td>.31 (1.0)</td>
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<tr>
<td>Marijuana use (SD)</td>
<td>2.0 (2.4)</td>
</tr>
</tbody>
</table>

Note. SD = Standard Deviation. Sx = Symptoms. Symptom counts are algorithms of self- and informant report on diagnostic interview and questionnaires. Higher scores for personality and substance use measures indicated that personality trait was more descriptive of the participant or reflected increased levels of the specific substance use measure.
childhood inattention was associated with higher neuroticism and lower agreeableness, which in turn, predicted increased alcohol problems. Similarly, both neuroticism ($\beta = .06, [.02, .10], p = .01$) and agreeableness ($\beta = .04, [.01, .07], p = .02$) statistically mediated the association between hyperactivity–impulsivity and alcohol problems, such that childhood hyperactivity–impulsivity was associated with both higher neuroticism and lower agreeableness, which each predicted more alcohol problems.

3.2.2. Marijuana use and problems
Childhood hyperactivity–impulsivity, but not inattention, had a statistically significant direct effect on marijuana use ($\beta = .16, [.06, .26], p = .007$). However, both inattention ($\beta = .14, [.08, .19], p < .001$) and hyperactivity–impulsivity ($\beta = .07, [.01, .12], p = .04$) indirectly predicted marijuana use. For inattention, specific indirect pathways involving conscientiousness ($\beta = .06, [.03, .11], p = .006$) and openness ($\beta = .04, [.02, .07], p = .01$) were statistically significant, such that higher childhood inattention scores were associated with lower conscientiousness and higher openness, each of which then predicted increased marijuana use. Similarly, specific indirect effects involving conscientiousness emerged in the association between hyperactivity–impulsivity and marijuana use ($\beta = .05, [.01, .09], p = .02$), such that hyperactivity–impulsivity was associated with lower conscientiousness, which in turn, statistically predicted higher marijuana use (see Fig. 2).

Childhood inattention did not exert significant direct effects on marijuana problems. But both inattention and hyperactivity–impulsivity exerted indirect effects on marijuana problems (inattention: $\beta = .13, [.08, .18], p < .001$; hyperactivity–impulsivity: $\beta = .08, [.03, .13], p = .01$). Inattention was associated with increased marijuana problems via conscientiousness ($\beta = .05, [.01, .09], p = .05$) and openness ($\beta = .04, [.02, .06], p = .008$), whereas conscientiousness ($\beta = .03, [.01, .05], p = .06$) slightly, but not statistically, mediated the association between hyperactivity–impulsivity and marijuana problems.

3.2.3. Drug use and problems
Hyperactivity–impulsivity, but not inattention exerted a significant direct effect on drug use ($\beta = .14, [.04, .24], p = .02$). However, both symptom dimensions indirectly influenced drug use (inattention: $\beta = .17, [.12, .22], p < .001$; hyperactivity–impulsivity: $\beta = .12, [.06, .17], p < .001$). As depicted in Fig. 3, examination of the specific indirect effects again revealed that both conscientiousness ($\beta = .08, [.03, .11], p = .004$) and openness ($\beta = .03, [.01, .05], p = .02$) significantly mediated the association between childhood inattention and drug use, whereas conscientiousness ($\beta = .05, [.02, .08], p = .01$) and

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**Note:** *p < .05, **p < .01, ***p < .001. Numbers to the left of the dash are the direct effects and numbers on the right of the dash are the sum of the indirect effects.*

**Fig. 1.** Direct and indirect effects of childhood ADHD symptom dimensions on alcohol use and problems: Mediation via personality traits.
agreeableness ($\beta = .03, [.007, .05], p = .03$) significantly mediated the association between child hyperactivity–impulsivity and drug use.

The direct effect of childhood hyperactivity–impulsivity on drug problems was statistically significant ($\beta = .14, [.06, .22], p = .009$). Further, indirect effects also emerged in the association between inattention and drug problems ($\beta = .13, [.08, .19], p < .001$) as well as in the association between hyperactivity–impulsivity and drug problems ($\beta = .09, [.04, .14], p = .002$). Point estimates revealed that pathways involving both neuroticism ($\beta = .06, [.02, .10], p = .02$) and openness ($\beta = .04, [.01, .07], p = .02$) accounted for the association between inattention and drug problems. When examining mediators of the association between hyperactivity–impulsivity and drug problems, none of the specific point estimates were statistically significant, although marginally significant specific paths emerged involving neuroticism ($\beta = .04, [.004, .09], p = .07$) and agreeableness ($\beta = .03, [.003, .05], p = .06$).

4. Discussion

The current study aimed to determine if personality traits accounted for the association between childhood ADHD symptoms, substance use, and substance-related problems in young adults. Several key findings emerged and we discuss each, in turn. First, and most importantly, indirect effects involving personality traits consistently emerged across all models, indicating that personality traits may be of critical importance for understanding links between childhood ADHD symptom dimensions and substance use as well as substance-related problems. These findings are in line with recent work highlighting the importance of personality factors in shaping externalizing comorbidity (Davis, Cohen, Davids, & Rabindranath, 2015; Martel, Gremillion, & Tackett, 2014).

Second, direct effects of childhood hyperactivity–impulsivity, but not inattention, were observed in several models (with alcohol use being the exception). Thus, it appears that childhood hyperactive–impulsive symptoms in particular may be relevant for directly predicting substance use and problems in adulthood. This finding is in line with prospective work indicating that hyperactivity–impulsivity, but not inattention, is associated with earlier onset of substance use and predictive of later substance dependence (Elkins, McGue, & Iacono, 2007) as well as models implicating a specific role of impulsivity in the onset of SUDs (Verdejo-García, Lawreunce, & Clark, 2014).

Third, our hypotheses that low conscientiousness, low agreeableness, and high neuroticism would emerge as key mediators were partially supported. Conscientiousness appeared to be particularly relevant for understanding links between childhood ADHD symptoms and marijuana and drug use. However, when examining models predicting...
substance-related problems, both neuroticism and agreeableness emerged more consistently as statistical mediators linking childhood ADHD symptom dimensions with later problems, particularly for alcohol-related problems and drug problems. Therefore, different traits may be involved in explaining links between childhood ADHD and subsequent use versus the development of substance-related problems, consistent with the accelerated gateway model. It may be the case that personality traits (i.e., agreeableness and neuroticism) may be more relevant for understanding how problematic substance use develops in individuals who have already begun using substances, potentially as a method of regulating emotions (Lynne, Frone, Russell, & Mudar, 1995). Furthermore, low conscientiousness could indicate more carelessness and less goal-oriented behavior, which then might lead to initial substance use but not necessarily problems. The current findings highlight potentially separable mechanisms that link childhood ADHD behaviors to substance use versus problems.

Fourth, high levels of openness consistently emerged as a statistical mediator in models predicting drug use and problems. Past work has linked high levels of openness to increased rates of substance use (Zvolensky, Taha, Bono, & Goodwin, 2015) and substance-related problems in adults (Flory, Lynam, Milich, Leukefeld, & Clayton, 2002). Further it may be the combination of high levels of openness with other traits that may increase risk for substance-related problems (Zhang, Bray, Zhang, & Lanza, 2015). Future work may benefit by examining this possibility.

Fifth, extraversion did not appear to play a role in any of the associations between childhood ADHD and substance use and problems, despite findings suggesting that reward or novelty-seeking behavior leads to the initiation of substance use in impulsive populations (Beauchaine & McNulty, 2013). Even so, extraversion is comprised of many facets, of which novelty-seeking is just one. More work is needed to determine how extraversion and its trait facets are involved in the etiology of both substance use and substance-related problems.

Some limitations of the current work should be noted. Data are cross-sectional, and rely on retrospective reports of childhood symptoms from participants and informants. Thus, the temporal ordering of variables in a mediation model cannot be assured. However, we used report of symptoms during childhood (i.e., ages 5–12) in order to draw some preliminary conclusions about the ordering of variables. Prospective data from childhood to adulthood could provide a more robust test of these associations. Additionally, we examined self-reports of alcohol, marijuana, and drug use and problems at a single time point, despite past work suggesting some developmental progression in class of use and abuse. Further research should explore the role of personality traits in regard to the developmental progression of use to substance-related problems. Lastly, we did not examine nicotine use and problems as an

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**Fig. 3.** Direct and indirect effects of childhood ADHD symptom dimensions on drug use and problems: Mediation via personality traits.
outcome, even though nicotine use has shown to be prevalent in ADHD populations (Milberger, Biederman, Faraone, Chen, & Jones, 1997). Future work would benefit from such examination.

Overall, personality traits appeared to partially account for the association between childhood ADHD symptoms and substance use and problems in adulthood, and may play a critical role in the development of substance use and related problems in adulthood. These findings provide additional support for the notion that personality traits may be useful for understanding overlap among disorders on the externalizing spectrum.

References


