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Personality Traits Elucidate Sex Differences in Attention-Deficit/Hyperactivity Disorder Comorbidity During Early Childhood

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Abstract

Attention-Deficit/Hyperactivity Disorder (ADHD) is highly comorbid with other childhood disorders, and there are striking sex differences in this comorbidity, particularly during early childhood. For example, boys with ADHD are more likely to exhibit comorbid disruptive behavior and neurodevelopmental disorders, compared to girls, during early childhood. Yet, explanations for these well-established sex differences remain in short supply. The current study evaluated the novel hypothesis that personality traits may serve as intermediate phenotypes that help explain sex differences in common ADHD comorbidity profiles during early childhood. Study participants were 109 children between the ages of 3 and 6 and their primary caregivers and teachers/daycare providers, recruited from the community and over-recruited for ADHD-related problems. Primary caregivers completed the Child Behavior Checklist, and teachers/daycare providers completed the Teacher Report Form as a measure of child behavior problems. Examiners completed the California Q-Sort as a measure of child personality traits. Moderated mediation analyses suggested that personality traits explain associations between ADHD and oppositional-defiance, aggression, and language problems in a sex-specific manner. While high neuroticism mediated associations between ADHD and oppositional-defiance in girls, disagreeableness mediated associations between ADHD and aggression and low conscientiousness mediated associations between ADHD and neurodevelopmental language problems in boys. Sex differences in trait-psychopathology associations may help explain sex differences in comorbidity profiles with possible implications for child assessment and personalized early intervention.

Keywords

ADHD; aggression; temperament

Attention-Deficit/Hyperactivity Disorder (ADHD) is a common, and yet highly impairing, disorder that affects boys approximately three times as often as girls as early as it can be

diagnosed during early childhood (APA, 2000; Arnold, 1996). ADHD has high comorbidity with common disruptive behavior disorders and neurodevelopmental disorders during early childhood (Frick & Nigg, 2012; Pelham, Foster, & Robb, 2007; Polanczyk et al., 2007). Boys and girls with ADHD exhibit strikingly different comorbidity profiles; boys are more likely to exhibit comorbid disruptive behavior disorders like Oppositional-Defiant Disorder (ODD) and Conduct Disorder (CD) and common neurodevelopmental disorders like language disorders/impairment during early childhood, while girls are more likely to exhibit comorbid internalizing disorders during adolescence (Angold, Costello, & Erkanli, 1999; Chronis-Tuscano et al., 2010; Gaub & Carlson, 1997; Levy, Hay, Bennett, & McStephen, 2004). Yet, explanations for sex differences in comorbidity patterns remain in short supply.

Temperament and personality traits offer a psychologically rich context for potentially clarifying differential comorbidity patterns in boys and girls. Since temperament and personality traits reflect early-emerging and relatively enduring dispositional individual differences in thinking, feeling, and behaving, influenced by both biological and environmental factors, they may represent intermediate phenotypes, or risk markers, of early psychopathology (see Rothbart, 2011; Tackett, 2006; Zentner & Shiner, 2012). The most widely used personality trait model is the Five Factor personality model which includes the following higher-order traits: Neuroticism (i.e., tendency to experience anxiety, depression, and other negative emotions, as well as difficulty coping with stress), Extraversion (i.e., warmth, sociability, and gregariousness), Openness to Experience (i.e., intellectual curiosity, imagination, and interest in new experiences), Agreeableness (i.e., altruism, trust, compliance, and concern, related to affiliation), and Conscientiousness (i.e., goal-directed behavior, organization, and impulse control; McCrae & Costa, 1987). Although primarily developed with adults, a substantial literature has suggested this personality model is also useful and valid in children, even in preschool-age children (e.g., De Fruyt et al., 2006; Goldberg, 2001; Halverson et al., 2003; Tackett et al., 2012). Importantly, much of this work has not relied on top-down approaches (i.e., the direct application of adult models to younger age groups), but has produced evidence for the Five Factor Model in children based on bottom-up, empirically based work originating in childhood samples (De Fruyt et al., 2006; Halverson et al., 2003; Tackett et al., 2012). Further, personality traits are substantially related to comparable temperament traits, both theoretically and empirically (e.g., neuroticism is related to negative affect; De Pauw, Mervielde, & Van Leeuwen, 2009; McCrae et al., 2000; Shiner & Caspi, 2003). Drawing on this rich theoretical and empirical background, the present study utilizes a personality trait framework to evaluate dispositionally-based explanations of comorbidity in childhood psychopathology.

Although it is well-established that personality traits are associated with psychopathology, explanations for these associations are heavily debated. Personality traits may predispose individuals to psychopathology, lie on the same continuum as psychopathology, exacerbate psychopathology, or be complicated by psychopathology with some consensus that extreme levels of personality traits at least increase risk for psychopathology (De Bolle, Beyers, De Clercq, & De Fruyt, 2012; Klein, Kotov, & Bufferd, 2011; Shiner & Caspi, 2003; Tackett, 2006; Watson, Kotov, & Gamez, 2006). That is, extreme levels of personality traits appear to predispose at least some children to psychopathology, and this seems especially true for young children (Dougherty et al., 2012; Eisenberg et al., 2001; Frick et al., 2005; Kochanska

et al., 2009). Further, personality traits and psychopathology share similarities at a conceptual level and often share very similar items sets (although associations often survive corrections for overlapping items; Lemery, Essex, & Smider, 2002; Lengua, West, & Sandler, 1998), suggesting that they are related, and potentially overlapping, constructs. Therefore, personality traits may have utility for explaining patterns of associations between different disorders, or comorbidity between disorders.

In particular, since personality traits exhibit well-established sex differences, they may be able to help explain sex differences in patterns of comorbidity associated with ADHD even during early childhood. Many prominent sex differences in personality traits first emerge during early childhood. Boys exhibit higher levels of extraversion and the related temperament trait of surgency (i.e., positive emotional reactivity), beginning early during childhood (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006; Gartstein & Rothbart, 2003). Girls exhibit higher levels of conscientiousness and the associated temperament trait of effortful control (Else-Quest et al., 2006), as well as higher levels of agreeableness (Schmidt, Realo, Voracek, & Allik, 2008). Finally, girls exhibit higher levels of neuroticism, perhaps particularly during adolescence (Schmidt, Realo, Voracek, & Allik, 2008; Soto, John, Gosling, & Potter, 2011).

Personality traits also exhibit differential associations with specific types of psychopathology (Martel, 2009; Nigg, 2006; Tackett, 2006), beginning as early as preschool (Dougherty et al., 2012; Martel, Gremillion, & Roberts, 2012). High neuroticism seems to be associated with psychopathology in general, including ADHD, disruptive behavior problems (particularly oppositional defiance, Stringaris & Goodman, 2009), and anxiety and mood problems (Lahey, 2009; Kotov, Gamez, Schmidt, & Watson, 2010), as well as largely explaining the comorbidity between externalizing and internalizing problems in youth (Tackett, Waldman, Van Hulle, & Lahey, 2011; Tackett et al., 2013). However, low agreeableness is specifically associated with disruptive behavior problems such as CD, and low conscientiousness is highly associated with ADHD and neurodevelopmental problems, particularly during early childhood (Blair & Razza, 2007; De Pauw & Mervielde, 2011; Parker, Majeski, & Collin, 2004; Tackett, Martel, & Kushner, 2012). Finally, high extraversion has only been inconsistently associated with ADHD (Nigg et al., 2002) and may be most specifically associated with ADHD hyperactivity-impulsivity (Martel & Nigg, 2006), whereas low extraversion is typically linked to depression (De Bolle et al., 2012; Kotov, Gamez, Schmidt, & Watson, 2010; Tackett, 2006). This previous research also highlights the extent to which childhood dispositions facilitate psychopathology research by highlighting potential causal factors, developmental pathways, and clinically relevant subtypes within existing psychopathology categories (De Bolle et al., 2012; Nigg, 2006; Stringaris and Goodman, 2009; Tackett et al., 2013). Thus, an integration of child temperament and personality into research on child psychopathology holds great potential for highlighting mechanisms underlying psychopathology development, emergence, and manifestation.

The current study extends prior work on sex differences in traits and ADHD comorbidity by evaluating whether personality traits can explain, or mediate, associations between ADHD and early childhood comorbid disorders. The current study does this preliminarily by

examining correlational structure in a cross-sectional study of young children during an understudied and yet important early developmental period when these sex differences in comorbidity patterns are first able to be reliably measured. To this end, the current study will evaluate whether personality traits mediate, or explain, associations between ADHD and its most commonly comorbid early childhood disorders/problems: oppositional defiance, conduct problems like aggression, and neurodevelopmental language problems. In addition, moderation of such effects by child sex will be examined (i.e., moderated mediation). In accordance with prior literature on trait associations with ADHD and commonly comorbid disorders (e.g., Martel, 2009; Nigg, 2006; Tackett, 2006), it was predicted that neuroticism would explain associations between ADHD and oppositional-defiance, disagreeableness would explain associations between ADHD and conduct problems like aggression, and low conscientiousness would explain associations between ADHD and neurodevelopmental problems. It was further predicted that such mediating effects would be moderated by child sex in accordance with established sex differences in these personality traits (e.g., Else-Quest et al., 2006; Schmitt, Realo, Voracek, & Allik, 2008), such that high neuroticism would more likely account for ADHD comorbidity in girls, whereas low agreeableness and conscientiousness would more likely account for ADHD comorbidity in boys.

METHODS

Participants

Overview—Participants were 109 children between the ages of 3 and 6 ($M=4.77$ years, $SD=1.11$) and their primary caregivers (hereafter termed parents for simplicity; 67% mothers with the remaining 33% fathers+mothers, fathers only, foster parents, or grandmothers with guardianship). Fifty-nine percent ($n=64$) of the sample was male, and 32% of the sample was ethnic minority (23% African American and 8% other including Latino, American Indian, and mixed race children). Parental educational level ranged from unemployed to highly skilled professionals, with incomes ranging from below \$20,000 to above \$100,000 annually (30% less than \$20,000; 15% \$20–40,000; 14% \$40–60,000; 9% \$60–80,000; 8% \$80–100,000; 15% over \$100,000). Based on multistage and comprehensive diagnostic screening procedures (detailed below), children were provisionally classified into two groups: those with ADHD ($n=61$, including those with comorbid psychopathology; 6 predominantly inattentive, 26 predominantly hyperactive-impulsive, and 29 combined presentation) and those without ADHD ($n=48$). The non-ADHD group included children with subthreshold symptoms (i.e., fewer 6 ADHD symptoms) to provide a more continuous measure of ADHD symptoms, consistent with research suggesting that ADHD may be better captured by continuous dimensions than categorical designations (Marcus & Barry, 2011) and to increase statistical power. No siblings were included.

Recruitment and Identification—Participants were recruited from an urban Southern United States community primarily through direct mailings to families with children between the ages of 3 and 6 and internet postings, as well as through advertisements in newspapers and flyers posted at doctors' offices, community centers, daycares, and on campus bulletin boards. In order to oversample clinical cases due to the current study's

focus on clinical problems and comorbidity, two sets of advertisements were utilized; one set of advertisements targeted children between ages 3 and 6 with disruptive behavior problems and/or attention problems and a second set of advertisements targeted children between ages 3 and 6 without these types of problems. After recruitment, families passed through a multi-gated screening process. An initial telephone screening was conducted to rule out children prescribed long-acting psychotropic medication (i.e., antidepressants) or children with neurological impairments, mental retardation, psychosis, autism spectrum disorders, seizure history, head injury with loss of consciousness, or other major medical conditions. Only 10 families were screened out at this phase, usually due to parent-reported neurological condition (e.g., seizure disorder) or autism spectrum disorder. All families screened into the study at this point completed written and verbal informed consent procedures, and all procedures were consistent with the local university Institutional Review Board, the National Institute of Mental Health, and APA guidelines. Participating caregivers each received \$30, and the child received a small prize for participation.

During the second stage, parents and children attended a three-hour campus laboratory visit. Parents of children taking psycho-stimulant medication were asked to consult with a physician about discontinuing children's medication for 24 to 48 hours prior to the visit depending on their dosage and type of medication in order to ensure a more accurate measure of cognitive performance. However, only one child was taking psychostimulant medication in the current study, and this family reported discontinuation of medication for the visit. Before and during the laboratory visit, diagnostic information was collected via parent and teacher/other caregiver ratings. The primary caregiver, usually the mother, completed the Kiddie Disruptive Behavior Disorders Schedule (K-DBDS; Leblanc et al., 2008), a semi-structured diagnostic interview for preschoolers modeled after the Schedule for Affective Disorders and Schizophrenia for School-Age Children, administered by a trained graduate student clinician. Questions about endorsed DBD symptoms were followed by questions about symptom severity, duration, onset, and cross-situational pervasiveness. For endorsed symptoms to count toward ADHD diagnosis, the symptom must have been present in more than one setting (i.e., school, home, or public) and must have occurred frequently compared to same-aged peers. The K-DBDS demonstrates high test-retest reliability and high inter-rater reliability in the preschool population (LeBlanc et al., 2008). In the current study, fidelity to interview procedure was determined via stringent checkout procedures before interview administration. In addition, reliability of interviewer ratings was determined by blind ratings of interviews from each interviewer on 10% of families. Inter-rater clinician agreement was adequate for ADHD symptoms ($ICC=.97$).

Families were mailed teacher/other caregiver questionnaires one week prior to the laboratory visit and instructed to provide the questionnaires to children's teacher and/or daycare provider or babysitter who then mailed the completed questionnaires back to the university. When available, teacher/other caregiver report on DBD symptoms was obtained via report on the Disruptive Behavior Rating Scale, a reliable and valid symptom checklist for use with preschool-age children (DBRS; Barkley & Murphy, 2006). Unfortunately, teacher/other caregiver report on child DBD symptoms was only available on 50% of participating families with approximately 67% of completed teacher/other caregiver report available from teachers, with most of the remaining questionnaires completed by daycare providers or

babysitters. Some families did not have teacher/other caregiver report available because they could not identify a second reporter; however, in most cases of missing data, teachers/other caregivers did not return the questionnaire measures. Response rate did not differ based on child DBD diagnostic group ($\chi^2[3]=.59, p=.9$).

Ultimately, clinical diagnoses of ADHD were determined by the Principal Investigator, a licensed clinical psychologist, after a review of parent ratings on the K-DBDS and (when available) teacher/other caregiver ratings on the DBRS, consistent with current best practice guidelines for current diagnosis (Pelham, Fabiano, & Massetti, 2005). A second blind trained diagnostician also independently reviewed parent and teacher ratings of child symptoms to reach a diagnosis with a 100% agreement rate ($\kappa=1$) on a randomly-selected ten percent of cases, confirming the reliability of this diagnostic procedure.

Measures

Child Behavioral and Emotional Problems—Child behavioral and emotional problems were measured via parent (again, usually the mother) and teacher/other caregiver report on the Child Behavior Checklist (CBCL) and Caregiver-Teacher Report Form (C-TRF) ages 1.5 through 5 (Achenbach & Rescorla, 2000). This measure has well-established reliability and validity for the preschool age range (Achenbach & Rescorla, 2000). Raw scores for the ADHD, Oppositional-Defiant Disorder (ODD), and aggression scales were utilized. These scales from the CBCL and C-TRF scales exhibited high internal consistency in our sample (α range=.96-.97). In order to be sensitive to the young age of the sample, maintain a focus on continuous dimensions of psychopathology, and increase statistical power, primary comorbidity analyses utilized parent report on the aforementioned scales, while secondary analyses evaluated rater effects and possible shared source variance by examining teacher report on the same scales.

Language Problems—The Peabody Picture Vocabulary Test-Fourth Edition (PPVT-4; Dunn & Dunn, 2007), a clinical measure of receptive language, provides information about young children's receptive vocabulary by asking the child to point to one of four pictures that matches a specific prompt. The PPVT-4 has high internal consistency (between .95 and .97) and high test-retest reliability (from .92 to .96) in the preschool age range (Dunn & Dunn, 2007). Further, the PPVT-4 demonstrated construct and content validity via significant associations with other language measures and clinical utility via its ability to discriminate among children with and without language disorders (Dunn & Dunn, 2007). Raw scores were calculated by subtracting the number of errors made from the highest numbered item completed. Scores were then reversed so that higher scores indicate worse receptive language ability.

Personality Traits—To measure personality traits, an examiner completed the California Child Q-Sort (CCQ; Block & Block, 1980) after spending three hours interacting with the child during the on-campus laboratory visit. An examiner, rather than a parent, completed the CCQ in order to eliminate shared source variance; yet correlations between examiner ratings of personality traits on the CCQ and parent ratings of corresponding temperament traits on the Child Behavior Questionnaire (CBQ; Putnam & Rothbart, 2006) were

significant and in the moderate range, as expected (e.g., r between examiner-rated neuroticism on CCQ and parent-rated negative affect on the CBQ was .4, $p < .01$). The CCQ is a typical Q-Sort consisting of 100 cards which must be placed in a forced-choice, nine-category, rectangular distribution. The rater describes the child by placing an even number of descriptive cards in one of the categories, ranging from one (least descriptive) to nine (most descriptive). Scales devised by John and colleagues (1994), validated for use with children, were utilized to measure the Five Factors. The composite scale scores were generated by reverse-scoring selected items and computing the average. Scale internal (i.e., alpha) reliabilities for neuroticism, extraversion, agreeableness and conscientiousness were .65 or above; the scale reliability for openness was .54 so it was not considered further.

Item Overlap Between Traits and Behavioral/Emotional Problems—In order to control for the possibility that shared item content in personality trait and behavioral/emotional problems scales might inflate associations between the two domains, items judged to overlap were identified and removed. Possible item overlap between personality traits and child behavioral/emotional problems was identified by two independent raters based on conceptual similarity. Two items on the agreeableness scale (i.e., “helpful and cooperative” and “eager to please”) were judged to overlap with items on the aggression scale from the CBCL. One item on the conscientiousness scale (i.e., “attentive and able to concentrate”) was judged to overlap with an item from the ADHD scale from the CBCL. These items were eliminated from the relevant personality scales. Although the reliability of the agreeableness remained acceptable ($\alpha = .83$), the reliability of the conscientiousness scale dropped to an alpha of .54. Due to this low reliability, primary analyses utilized the personality scales with overlapping items included, but secondary checks examined whether results changed when using the non-overlapping scales.

Data Analysis

Confirmatory mediation analyses were conducted using the powerful bootstrapping approach recommended by Preacher, Rucker, and Hayes (2007) and MacKinnon and Fairchild (2009). We utilized the Preacher, Rucker, and Hayes (2007) bootstrapping approach to mediation as a test of indirect effects. This method, available through an on-line macro that can run through SPSS (PASW) 18, provides an estimate of indirect effects and their significance using z -statistics generated from multiple resamples of the data set, a procedure which increases estimate precision and statistical power. In addition, the macro calculates conditional indirect effects, or moderated mediation (and mediated moderation; i.e., indirect effects and pathway estimates that are conditional on a moderating variable) using t -statistics, followed by bootstrapped estimates and significance tests at specific levels of the moderator variable (see Preacher, Rucker, & Hayes, 2007 for more information). These tests make no assumptions about the distribution of the variables or the test statistics and are not based on large-sample theory; therefore, they are appropriate for use with relatively small samples (Preacher & Hayes, 2004).

RESULTS

As shown in Table 1, the ADHD and non-ADHD diagnostic groups did not differ on child sex, age, or family income (all $p > .05$). However, child ethnicity significantly differed between the groups ($p < .05$); there was a significantly higher percentage of ethnic minorities in the ADHD clinical group. Therefore, child ethnicity was covaried in all subsequent mediation analyses. As expected, children with clinically diagnosed ADHD exhibited significantly greater CBCL ADHD, ODD, and aggression problems ($p < .01$), compared to children without ADHD. Further, children with clinically diagnosed ADHD exhibited significantly higher neuroticism and significantly lower agreeableness and conscientiousness compared to children without ADHD ($p < .01$). Further, as shown in Table 2, neuroticism was significantly positively associated with CBCL ADHD, ODD, and aggression problems (all $p < .01$), while agreeableness and conscientiousness were significantly negatively correlated with CBCL ADHD, CBCL ODD, CBCL aggression, and receptive language problems (all $p < .01$). All effect sizes were in the medium to large range ($r = .3-.55$; $d = .5-.8$).

In order to evaluate whether dispositional traits differentially mediated associations between CBCL ADHD and commonly-comorbid symptoms (i.e., CBCL ODD, CBCL aggression, receptive language problems) based on child sex (and controlling for child ethnicity), moderated mediation analyses were conducted using bootstrapped indirect effect mediation tests. Based on these analyses and as shown in Figure 1, neuroticism significantly partially mediated the association between CBCL ADHD and ODD problems for girls (boot $z = 2.07$, $p = .04$), but not boys (boot $z = .54$, $p = .59$). As shown in Figure 2, disagreeableness significantly partially mediated the association between CBCL ADHD and aggression problems in boys (boot $z = 2.26$, $p = .02$), but not girls (boot $z = .72$, $p = .47$). As shown in Figure 3, low conscientiousness significantly partially mediated the association between CBCL ADHD and receptive language problems in boys (boot $z = 1.96$, $p = .05$), but not girls (boot $z = .6$, $p = .55$). There were no other significant moderating effects of sex on any of the pathways in the models (all $p > .05$).

Secondary Checks

All moderated mediation effects generally held using the non-overlapping personality scales. That is, disagreeableness significantly partially mediated the association between CBCL ADHD and aggression problems in boys (boot $z = 2.36$, $p = .02$), but not girls (boot $z = .55$, $p = .58$). Low conscientiousness marginally partially mediated the association between CBCL ADHD and receptive language problems in boys (boot $z = 1.67$, $p = .09$), but not girls (boot $z = .55$, $p = .58$).

Results also generally held using teacher/daycare provider report instead of parent report of ADHD in the smaller subset of children for whom teacher/daycare provider report was available. That is, neuroticism marginally partially mediated the association between C-TRF ADHD and ODD in girls (boot $z = 1.75$, $p = .08$), but not boys (boot $z = .62$, $p = .53$). Disagreeableness significantly partially mediated the association between C-TRF ADHD and aggression problems in boys (boot $z = 2.54$, $p = .01$), but not girls (boot $z = 1.18$, $p = .24$). Low conscientiousness significantly partially mediated the association between C-TRF

ADHD and receptive language problems in boys (boot $z=2.19$, $p=.03$), but not girls (boot $z=.2$, $p=.84$).

DISCUSSION

The current study extends prior work on sex differences in comorbidity patterns associated with ADHD by evaluating personality traits as one potential intermediate phenotype for these differences, albeit preliminarily by examining correlational structure in a cross-sectional study. Results suggested that personality traits explain comorbidity between ADHD and other common childhood disorders in a sex-specific manner. Neuroticism mediated associations between ADHD and ODD in girls. However, disagreeableness mediated associations between ADHD and aggression in boys, and low conscientiousness mediated associations between ADHD and neurodevelopmental receptive language problems in boys. Results generally held using non-overlapping personality trait and psychopathology scales and when utilizing teacher report of ADHD.

Results of the current study suggest that child personality traits may be useful for shedding light on patterns of common comorbidity associated with preschool ADHD (Martel, 2009; Martel & Nigg, 2006; Parker, Majeski, & Collin, 2004). For example, children with ADHD with high disagreeableness may be at increased risk for comorbid conduct problems such as aggression, in line with work suggesting that children with conduct problems exhibit high disagreeableness and high callous-unemotional traits (Frick et al., 1994; 2003). In contrast, children with ADHD with high neuroticism may be at increased risk for ODD, consistent with recent work suggesting ODD may be best considered a disorder of high negative affect (Stringaris, Maughan, & Goodman, 2010). Finally, children with ADHD with low conscientiousness may be at increased risk for receptive language problems and, speculatively, later academic problems (Blair & Razza, 2007). Thus, personality traits may be a useful risk marker for common patterns of comorbidity, potentially furthering study of underlying neurobiological (Insel et al., 2010) and genetic (Tackett et al., 2011; Tackett et al., 2013) factors.

Further, in the current study, personality traits seem to explain common patterns of co-occurrence between ADHD and other disorders differentially based on child sex. In line with normative sex differences in personality traits (Else-Quest et al., 2006; Schmitt et al., 2008), high neuroticism was particularly important for explaining the co-occurrence of ADHD and ODD in girls, while high disagreeableness was particularly important for explaining co-occurrence between ADHD and aggression in boys and low conscientiousness was important for explaining co-occurrence between ADHD and language problems in boys. Therefore, different personality traits may be important for explaining clinical comorbidity in girls and boys. This idea is in line with the constitutional variability model of sex differences in ADHD which suggests that different risk factors may be important for girls and boys with ADHD (James & Taylor, 1990; Rhee, Waldman, Hay, & Levy, 1999).

Since early assessment of child personality traits may be able to inform our understanding of common patterns of comorbidity in children with ADHD, they may be useful assessment targets. As assessment tools, children's personality profiles may provide valuable

information for early intervention strategies that might be able to be personalized based on child sex and/or personality profile, helping to elucidate early developmental psychopathology from developmentally normative behaviors (Conrod, Castellanos, & Mackie, 2008). Further, children's personality traits may be meaningfully related to impairment and future functioning (Stringaris & Goodman, 2009). Testing these ideas are important directions for future work.

Although the current study suggests that personality traits may be useful intermediate phenotypes that can help explain common forms of comorbidity in girls and boys with ADHD, the study had several salient limitations. Due to its cross-sectional design, the study is unable to evaluate whether personality traits increase vulnerability to these disorders, fall on the same spectrum as these disorders, exacerbate these disorders, or are exacerbated by these disorders (De Bolle et al., 2012; Shiner & Caspi, 2003; Tackett, 2006; Watson, Kotov, & Gamez, 2006). However, early evidence suggests that these personality associations may actually reflect common underlying influences on disorder comorbidity and/or increase risk for psychopathology as risk markers (Martel et al., 2010; Tackett et al., 2011). Further testing of this idea using longitudinal samples is needed. In addition, the sample size was relatively small. Therefore, there was limited statistical power to examine ADHD presentation-specific effects.

Important directions for future work including evaluating personality trait mediation of ADHD comorbidity profiles in larger samples and using longitudinal data. In addition, the current study's results should be replicated with other measures of personality traits (e.g., observational measures), as well as in other types of samples (e.g., clinical samples, general population samples, rural samples, samples of older children) to assess generalizability. Personality traits are likely not the only important factor useful for explaining comorbidity patterns; other potentially important factors (e.g., cognitive patterns) also deserve attention.

Overall, personality traits may help explain comorbidity between ADHD and other common childhood disorders in a sex-specific manner. Neuroticism mediated associations between ADHD and oppositional-defiance in girls. However, disagreeableness mediated associations between ADHD and aggression in boys, and low conscientiousness mediated associations between ADHD and neurodevelopmental receptive language problems in boys. Sex differences in trait-psychopathology associations may help explain sex differences in comorbidity profiles with possible implications for child assessment and personalized early intervention. These findings also highlight the possibility of sex-specific developmental trajectories and may ultimately help to predict distinct outcomes from early diagnostic cases of ADHD (i.e., multifinality).

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Figure 1.

Neuroticism Partially Mediates the Association Between ADHD and ODD in Girls, But Not Boys

Note. $*p < .05$. $**p < .01$. Ethnicity covaried.

Figure 2.
Disagreeableness Partially Mediates the Association Between ADHD and Aggression in Boys, But Not Girls

Note. $*p < .05$. $**p < .01$. Ethnicity covaried.

Figure 3.

Low Conscientiousness Mediates the Association Between ADHD Symptoms and Language Problems in Boys, But Not Girls

Note. $+<.1$. $*p<.05$. $**p<.01$. Ethnicity covaried.

Table 1

Descriptive Statistics on Sample

	ADHD <i>n</i> =61	non-ADHD <i>n</i> =48
Age	4.57(1.17)	4.93(1.04)
Sex (<i>n</i> ; % Male)	40(65.6)	24(50)
Ethnic Minority	27(44.2)	9(18.8)*
Income (mode; see below)	0	2,5
Parent-rated Inattention	14.62(7.17)	5.49(5.52)**
Parent-rated Hyper-Imp	18.08(6.8)	6.82(5.6)**
Teacher-rated Inattention	19.04(5.67)	4.05(4.04)**
Teacher-rated Hyper-Imp	17.48(6.15)	4.96(4.98)**
CBCL ADHD	8.63(2.99)	3.87(3.01)**
CBCL ODD	6.83(3.24)	3.44(3.05)**
CBCL Aggression	18.03(8.22)	7.89(7.23)**
Language Problems	69.49(24.77)	64.44(32.43)
Neuroticism	4.01(1.61)	3.03(1.03)**
Extraversion	6.38(1.69)	6.64(1.09)
Agreeableness	5.34(1.42)	6.52(.73)**
Conscientiousness	5.07(1.18)	5.81(.94)**

Note.

*
 $p < .05$.

**
 $p < .01$ based on chi-square or ANOVA/MANOVA.

Family income modes: 0=annual income less than \$20,000, 1=between \$20,000 and \$40,000, 2=between \$40,000 and \$60,000, 3=between \$60,000 and \$80,000, 4=between \$80,000 and \$100,000, and 5=over \$100,000 annually.

Table 2

Correlation Table

	CBCL ADHD	ODD	Aggression	Language Problems
Neuroticism	.36**	.41**	.43**	.11
Extraversion	.06	-.08	-.02	.002
Agreeableness	-.51**	-.51**	-.55**	-.31**
Conscientiousness	-.34**	-.3**	-.33**	-.38**

Note.*
 $p < .05$.**
 $p < .01$.