Published in final edited form as:
Pers Individ Dif. 2014 July 1; 64: 58–61. doi:10.1016/j.paid.2014.02.018.

Longitudinal Prediction of the One-Year Course of Preschool ADHD Symptoms: Implications for Models of Temperament-ADHD Associations

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Abstract

Despite the fact that Attention-Deficit/Hyperactivity Disorder (ADHD) is often conceptualized as an extreme trait, there remains controversy about the best way to understand associations between temperament traits and ADHD. The current study examines longitudinal associations between temperament traits and ADHD during early childhood in order to critically examine vulnerability and spectrum models of trait—ADHD associations. Study participants were 109 children between the ages of 3 and 6 and their primary caregivers and teachers/daycare providers, community-recruited for ADHD-related problems. Primary caregivers completed the Kiddie Disruptive Behavior Disorders Schedule semi-structured diagnostic interview at the initial appointment and one year later. At the initial appointment, primary caregivers completed the Child Behavior Questionnaire as a measure of child temperament traits. Results from the initial time point indicated that high neuroticism and high surgency were associated with inattentive and hyperactive-impulsive ADHD symptoms, and low effortful control was associated with hyperactive-impulsive ADHD symptoms. However, none of these traits predicted the one-year course of ADHD symptoms. Results are more consistent with a spectrum (vs. vulnerability) model of trait-psychopathology associations, suggesting that traits, but may not influence longitudinal course during early childhood.

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Keywords

ADHD; temperament; longitudinal; spectrum model

1.1. INTRODUCTION

Attention-Deficit/Hyperactivity Disorder (ADHD) is a common and impairing behavioral disorder characterized by symptoms of inattention and hyperactivity-impulsivity that often emerges first during early childhood, or by age 4 (APA, 2013; Keenan & Wakschlag, 2002). ADHD has been conceptualized as a disorder of extreme maladaptive temperament and/or personality traits (Martel, 2009; White, 1999). Yet, the nature of the associations between extreme levels of temperament and personality traits and ADHD behavioral manifestation remain relatively understudied, despite available theory.

Temperament traits are often emphasized in studies of early childhood development and have been defined as constitutionally-based individual differences in reactivity and self-regulation (Rothbart, 1989). Most commonly-used models of temperament traits converge on three higher-order traits: negative affect, surgency, and effortful control (Eisenberg et al., 1996; Rothbart, 1989). Negative affect is defined by a high level of negative emotions, including anger, sadness, and fear. Surgency can be defined by a high level of positive emotions related to approach or social behavior, including activity level. Effortful control refers to thoughtful, deliberate forms of regulation (Rothbart, Ahadi, & Evans, 2000).

Although ADHD has been conceptualized as an extreme temperament or personality trait, substantive explanations for associations between traits and ADHD remain largely unsubstantiated in the broader literature. There are a number of different models of trait-psychopathology associations. That is, it has been theorized that temperament traits may predispose individuals to psychopathology (vulnerability model), lie on the same continuum as psychopathology (spectrum model), or exacerbate (pathoplasty/exacerbation) or be exacerbated (complication/scar) by psychopathology (Shiner & Caspi, 2003; Tackett, 2006). In general, the vulnerability and spectrum models of trait-psychopathology associations have received most support (De Bolle, Beyers, W., De Clercq, & De Fruyt, 2012; Eisenberg et al., 2001; Van Leeuwen et al., 2007). Research examining associations between temperament traits and ADHD suggest that high surgency may be specifically associated with ADHD hyperactivity-impulsivity, and low effortful control may be specifically associated with ADHD inattention (De Pauw & Mervielde, 2011; Herzhoff, Tackett, & Martel, 2013; Martel & Nigg, 2006), in line with recent multiple pathway models of ADHD (e.g., Nigg et al., 2004; Sonuga-Barke, 2010). Of course, these associations do not differentiate between the aforementioned models of trait-psychopathology associations.

Teasing apart these models remains a difficult and understudied issue. However, longitudinal modeling may provide one means by which to shed light on these associations and provide some preliminary evidence to differentiate vulnerability and spectrum models. For example, the vulnerability and spectrum models both make a basic prediction that associations between extreme traits and psychopathology will be reflected in strong concurrent associations, whether because traits are increasing risk for psychopathology, as

posited by the vulnerability model, or because traits and psychopathology reflect positions on a shared underlying dimension, as posited by the spectrum model. Yet, the vulnerability model suggests an additional prediction that extreme traits will independently predict the onset and course of psychopathology. These two possibilities were tested in the current study. Study hypotheses were that high surgency and low effortful control would predict the onset and course of ADHD symptoms over a one-year period during early childhood (i.e., that both spectrum and vulnerability associations would be observed).

2.1. METHODS

2.1.1.Participants

2.1.1.1.Overview—Participants were 109 young children between the ages of three and six (*M*=4.34 years, *SD*=1.08) and their primary caregivers and identified teachers, daycare providers, or babysitters. Sixty four percent of the sample was male, and 36% of the sample was non-White. Family income ranged from below $20,000 to above $100,000 annually (see Table 1). Based on multistage and comprehensive diagnostic screening procedures (detailed below), children were recruited into two groups: ADHD (*n*=61) and non-ADHD children (*n*=48). The non-ADHD group included children with subthreshold symptoms, consistent with research suggesting that ADHD may be better captured by continuous dimensions than categorical diagnosis (Marcus & Barry, 2011).

2.1.1.2.Recruitment and Identification—Participants were recruited from the community primarily through direct mailings to families with children between the ages of three and six, advertisements, and internet postings written to over-recruit clinical cases. The multi-gated screening process included an initial telephone screening to rule out children prescribed psychotropic medication or children with neurological impairments, mental retardation, psychosis, autism spectrum disorders, seizure history, head injury with loss of consciousness, or other major medical conditions. All families screened into the study at this point completed written and verbal informed consent procedures consistent with the Institutional Review Board, the National Institute of Mental Health, and APA guidelines.

For families not screened out based on the exclusionary criteria detailed above, parents and preschoolers attended a campus laboratory visit. Parents of children taking psycho-stimulant medication (less than 5% of the sample) were asked to discontinue their children's medication for 24 to 48 hours prior to the visit to ensure a more accurate measure of cognitive performance. Before and during the laboratory visit, diagnostic information was collected via parent and teacher/caregiver ratings. Parents completed the Kiddie Disruptive Behavior Disorders Schedule (K-DBDS: Leblanc et al., 2008), a semi-structured diagnostic interview modeled after the Schedule for Affective Disorders and Schizophrenia for School-Age Children, administered by a trained graduate student clinician. The K-DBDS demonstrates high test-retest reliability and high inter-rater reliability in the preschool population (LeBlanc et al., 2008). Fidelity to interview procedure was determined via stringent check-out procedures before interview administration. Reliability of interviewer ratings was determined by blind ratings of interviews from each interviewer on 10% of

families, with acceptable inter-rater clinician agreement for ADHD symptoms (ICC=.82 or above).

Families were mailed teacher/caregiver questionnaires one week prior to the laboratory visit and instructed to provide the questionnaires to children's teacher, daycare provider, and/or babysitters, who then mailed the completed questionnaires back to the university. When available (i.e., available on 50% of participating families), teacher/caregiver report on DBD symptoms was obtained via report on the Disruptive Behavior Rating Scale (DBRS; Barkley & Murphy, 2006). Response rate did not differ based on child DBD diagnostic group ($X^2[3]=0.59$, $p=.9$). Ultimately, clinical diagnoses were determined by the Principal Investigator, a licensed clinical psychologist, after a review of parent ratings on the K-DBDS and (when available) teacher/caregiver ratings on the DBRS, consistent with current best practice guidelines for current diagnosis (Pelham, Fabiano, & Massetti, 2005).

At the third stage that occurred one year after the families' first appointments, the primary caregiver completed the K-DBDS a second time over the telephone with a trained staff person. Approximately 80% of families completed the one-year follow-up interview.

2.1.2. Measures

2.2.2.1.Symptom Counts for ADHD—Parent report on ADHD symptoms was available via the K-DBDS described above, both at the initial appointment and one year after the initial appointment. Inattentive and hyperactive-impulsive ADHD symptoms were significantly correlated ($r=.63–.73$; $p<.01$) across time points.

2.2.2.2.Temperament Traits—To measure negative affect, surgency, and effortful control, parents completed the very short form of the Child Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey & Fisher, 2001; Putnam & Rothbart, 2006). Negative affect, surgency, and effortful control were measured using the scales suggested by Rothbart et al (2001). Composite scale scores was generated by reverse-scoring selected items and computing the average. The scales had acceptable internal reliability coefficients of .70 or above in the current sample.

2.1.3. Data Analysis

Bivariate and partial correlations were conducted, followed by repeated-measures general linear models. Power analysis indicated that statistical power was adequate (.80) to detect a medium-size effect ($r = .25$).

3.1. RESULTS

3.1.1. Correlations between traits at initial time point and one year later

Bivariate correlations between temperament traits and ADHD symptom domains of inattention and hyperactivity-impulsivity at the initial time point and the one-year follow-up are shown in Table 2. In addition, partial correlations between temperament traits and ADHD symptoms of inattention and hyperactivity at the one-year follow-up, controlling for the initial level of symptoms, are shown in Table 2. As can be seen, correlations between

temperament traits and ADHD symptoms were, by and large, significant at the first time point and at the one-year follow-up (most $p<.01$). However, after controlling for initial levels of symptoms, temperament traits were no longer associated with ADHD symptoms at the one-year follow-up (all $p>.05$).

3.1.2. Repeated-Measures General Linear Models: Temperament Traits as Predictors of the One-Year Course of Early Childhood ADHD Symptoms

Several repeated-measures general linear models were conducted in order to evaluate the association between temperament traits on one-year change in inattentive and hyperactive-impulsive ADHD symptoms. Overall, temperament traits did not significantly predict one-year change in ADHD symptoms. That is, neither negative affect, surgency, or effortful control predicted the one-year course of inattentive (all $p \geq .6$). or hyperactive-impulsive ADHD symptoms (all $p \geq .14$).

4.1. DISCUSSION

The current study evaluated vulnerability and spectrum model explanations of trait-psychopathology associations in an early childhood sample of children over-recruited for ADHD-related problems and followed over one year. Overall, at the initial time point, high negative affect and high surgency were associated with inattentive and hyperactive-impulsive ADHD symptoms, and low effortful control was associated with hyperactive-impulsive ADHD symptoms. These results run somewhat counter to prior work in older children suggesting specificity of associations between effortful control and inattention and surgency and hyperactivity-impulsivity (Martel & Nigg, 2006), suggesting that affective traits such as negative affect and surgency may be particularly important during early development when neural circuitry is still exhibiting rapid growth (Martel, Gremillion, & Roberts, 2012).

Counter to predictions of the vulnerability model, none of these traits predicted the one-year course of ADHD symptoms. Therefore, these results seem to be more consistent with a spectrum model of trait-psychopathology associations, such that theoretically predicted associations between temperament traits and ADHD were largely accounted for by strong concurrent associations. Study results are consistent with some prior work testing these models using advanced statistical modeling approaches (De Bolle et al., 2012; Van Leeuwen et al., 2007). Therefore, results of the current study are consistent with the idea that traits reflect increased risk for psychopathology, with extreme levels perhaps synonymous with psychopathology. Thus, traits may share underlying etiological factors with psychopathology, serving as mediators of etiology-psychopathology associations and perhaps being useful endophenotypes (Krueger & Tackett, 2003; Tackett et al., in press). Extreme levels of such traits may, thus, be associated with increased levels of psychopathology, fluctuating with disorder symptoms over its course.

Of course, the current study has several notable limitations, perhaps most notably the fact that it provided only an imperfect test of the vulnerability and spectrum models. That is, since the vulnerability model had more stringent requirements for support, the current study cannot rule out this model. For example, relative stability of symptoms over time, small

sample size, use of only one measure of traits that shared source variance with parent ratings of symptoms, and a limited follow-up period might have decreased power to detect trait influences on change in symptoms over time. Therefore, important future directions for work in this area would be use of more innovative designs to test the directionality of these associations (e.g., quasi-experimental treatment designs), examination of these ideas in different types of samples and using different kinds of measures to assess generalizability, and incorporation of potentially shared etiologic factors to more stringently test spectrum and vulnerability models. Mediation of the association between causal influences and psychopathology by traits would support the spectrum model, whereas observance of direct unmediated associations between causal influences, traits, and psychopathology would be more supportive of the vulnerability model (see Tackett, Martel, & Kushner, 2012). The current study suggests the need for future work on this topic.

4.1.1. Conclusions

Overall, study results suggest that temperament traits exhibit robust associations with early ADHD psychopathology, but do not predict its one-year course, consistent with the spectrum model of trait-psychopathology associations.

Acknowledgements

This research was supported by National Institute of Health and Human Development Grant 5R03 HD062599-02 to M. Martel. We are indebted to the families who made this study possible.

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Highlights

- Models of trait-psychopathology associations remain unclear.
- Longitudinal study of associations between traits and ADHD may be informative.
- Temperament traits predicted onset, but not one-year course, of ADHD symptoms.
- Results provide support for a spectrum model of traitpsychopathology associations.

Table 1

Descriptive Statistics on Sample

	ADHD *n*=61	**non-ADHD *n*=48**
Age	4.49(1.01)	4.15(1.15)
Sex (*n*; % Male)	40(65.6)	24(50)
Ethnic Minority	27(44.2)	9(18.8)*
Income (mode; see below)	0	2,5
Inattention T1	4.80(2.65)	1.77(2.31)**
Hyper-Imp T1	7.3(1.84)	2.94(2.31)**
Inattention T2	5.36(3.21)	3(2.78)**
Hyper-Imp T2	6.52(2.7)	3.34(2.64)**
Negative Affect	4.68(.93)	3.69(.81)**
Surgency	4.96(1.02)	4.5(.84)*
Effortful Control	4.69(.87)	5.07(.87)*

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. T1=Initial time point. T2= One-year longitudinal time point.

Table 2

Correlations Between Temperament Traits and ADHD Symptoms At Initial Time Point and One-Year Longitudinal Time Point

Symptoms Traits	Inatt T1	Inatt T2	Inatt T2 (CT1)	Hyper-Imp T1	Hyperimp T2	Hyper-Imp T2 (CT1)
Negative Affect	.42**	.41**	.09	.53**	.41**	.01
Surgency	.30**	.27**	.01	.45**	.50**	.13
Effortful Control	−.15	−.13	−.06	−.30**	−.2	.05

Note. T1=Initial Time point. T2=One-year later. CT1=Controlling for initial time point.

* $p<.05$.

** $p<.01$.