Published in final edited form as:

J Atten Disord. 2016 January ; 20(1): 43–52. doi:10.1177/1087054712466915.

Dispositional Trait Types of ADHD in Young Children

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Abstract

Objective—This study evaluated a novel person-centered approach to parsing ADHD heterogeneity using dispositional traits.

Method—Participants were one hundred nine 3- to 6-year-olds, and their primary caregivers and day care providers/teachers who completed a multi-informant diagnostic procedure with longitudinal follow-up.

Results—Based on latent profile analysis, young children with ADHD could be divided into low control, high surgency, and high negative affect subgroups. The low control and high surgency groups exhibited increased parent- and teacher-rated hyperactive-impulsive and oppositional-defiant disorder (ODD) symptoms. Although the low control group exhibited the worst response inhibition, the high surgency group exhibited the worst working memory. Furthermore, the high surgency group exhibited high aggression and increasing levels of hyperactivity-impulsivity and ODD symptoms over time.

Conclusion—A subgroup of young children with ADHD with high surgency may be at particular risk for comorbid psychopathology and longitudinal worsening of symptoms.

Keywords

ADHD; maladaptive traits; cognitive control

ADHD is a common, but impairing neurodevelopmental disorder characterized by behavioral symptoms of inattention, hyperactivity, and impulsivity (American Psychiatric Association [APA], 2000; Frick & Nigg, in press; www. dsm5.org). However, complicating assessment and intervention, individuals with ADHD exhibit substantial heterogeneity, not only in behavioral symptoms (classified as subtypes, or presentations) but also in their cognitive profiles, personality traits, and multifactorial etiology (Barkley, 2006; Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005; E. J. S. Sonuga-Barke, 2005; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Yet, a satisfactory way of parsing this heterogeneity remains elusive.

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Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Historically, the most common method for parsing the behavioral heterogeneity of ADHD has been through the use of behavioral subtypes that rely on constellations and counts of relevant symptoms. Diagnostic and Statistical Manual of Mental Disorders (4th ed., text rev.; *DSM-IV-TR*; APA, 2000) designated three subtypes: predominantly inattentive (ADHD-PI; six or more symptoms of inattention, but fewer than six symptoms of hyperactivity-impulsivity), predominantly hyperactive-impulsive (ADHD-PHI; six or more symptoms of hyperactivity-impulsivity, but fewer than six symptoms of inattention), and combined type (ADHD-C; six or more symptoms of inattention *and* hyperactivity-impulsivity; APA, 2000). However, these subtypes have not been successfully externally validated (Lahey, Pelham, Loney, Lee, & Willcutt, 2005; Martel, Nikolas, & Nigg, 2007; Nigg et al., 2002; Solanto et al., 2007). *DSM-V* proposes four behavioral presentations: ADHD-PI, ADHD-PHI, and ADHD-C as described above, as well as inattentive (restrictive; six or more symptoms of inattention with two or fewer symptoms of hyperactivity-impulsivity; Frick & Nigg, in press; www.dsm5.org). However, thus far, little work has examined the external validity of these new presentations (for exceptions, see Carr, Henderson, & Nigg, 2010; Goth-Owens, Martinez-Torteya, Martel, & Nigg, 2010).

Person-centered, statistically driven approaches, such as latent class/profile and cluster analysis, have also been applied to the behavioral symptoms of ADHD. A series of articles utilizing this approach have suggested six clinical latent classes of ADHD, including moderate inattentive, moderate combined, moderate hyperactive, severe combed, severe inattentive, and hyperactive (Rasmussen et al., 2002; Todd et al., 2008). However, these latent classes have also not yet been successfully externally validated or translated into clinical practice. Intermediate phenotypes like executive function have also been suggested as having utility for parsing the heterogeneity of ADHD such that there may be a group of children with ADHD who also experience executive dysfunction, best captured by an executive dysfunction subtype(s) (Fair, Bathula, Nilolas, & Nigg, 2012; Nigg et al., 2005; Roberts, Martel, & Nigg, in press; Willcutt et al., 2005). Yet, this idea has received relatively little empirical attention, and preliminary data suggest that this idea has limited clinical utility, at least so far.

Dispositional traits, such as temperament and personality traits, are another potentially promising, and yet understudied, means by which to parse the heterogeneity within ADHD as they may be useful intermediate phenotypes of the disorder (Nigg, Goldsmith, & Sachek, 2004; Nolen-Hoeksema & Watkins, 2011). Two common temperament models often used to measure traits in children are Rothbart's (1989, 2007) model and Eisenberg's (Eisenberg, Fabes, Nyman, Bernzweig, & Pinuelas, 1994; Eisenberg, Spinrad, & Eggum, 2010) model. These models include four major traits: negative affect (i.e., high levels of anger, sadness, and fear), surgency (i.e., high positive affect and sociability), effortful control (i.e., thoughtful, deliberate regulation), and reactive control (i.e., reflexive, affectively driven regulation). The most common personality model used to measure traits in adults is the five-factor model (McCrae & Costa, 1987). The five factors from this model include neuroticism, extraversion, openness, agreeableness, and conscientiousness. Although, historically, temperament and personality traits were studied separately, recent work suggests that temperament and personality models overlap substantially with negative affect related to

neuroticism, surgency related to extraversion, and effortful control related to conscientiousness (e.g., De Fruyt et al., 2006; Halverson et al., 2003; Shiner & Caspi, 2003).

Dispositional traits from these models exhibit well-replicated associations with ADHD. Compared with typically developing individuals, those with ADHD have lower effortful control/conscientiousness, higher negative affect/neuroticism, lower agreeableness, and arguably higher surgency/extraversion (Martel & Nigg, 2006; Miller, Miller, Newcorn, & Halperin, 2008; Nigg et al., 2002; Parker, Majeski, & Collin, 2004). Specific relations between these ADHD symptom domains and personality traits have been found with inattention associated with low effortful control/conscientiousness and hyperactivity-impulsivity associated with low agreeableness and high extraversion/surgency (Martel & Nigg, 2006; Nigg et al., 2002; Parker et al., 2004). Furthermore, research suggests that low effortful control/conscientiousness may be associated with ADHD, specifically with inattention and executive dysfunction; high negative affect/neuroticism may be associated with psychopathology more generally, including ADHD and anxiety and mood problems; and higher surgency/extraversion may be associated with ADHD, particularly with hyperactivity-impulsivity, as well as other disruptive behavior problems (Kotov, Gamez, Schmidt, & Watson, 2010; Krueger et al., 2002; Lahey, 2009; Martel & Nigg, 2006).

In regard to subgroups within ADHD, theory by Nigg (2004) and Martel (2009) suggests that children with ADHD may fall into three groups: (a) poor control, (b) high extraversion, and (c) high negative affect, or introverted. In fact, in a large sample of children between ages 6 and 12, children with ADHD appeared to be able to be subdivided into at least three groups: poor control, high extraversion, and high negative affect, or introverted (Martel, Goth-Owens, Martinez-Torteya, & Nigg, 2010). Furthermore, these groups exhibited distinct profiles such that the poor control group had high levels of inattention, hyperactivity-impulsivity, and disruptive behavior problems; the extraverted group had high ADHD symptoms with few other behavior problems; and the high negative affect group had high levels of ADHD, disruptive behaviors, and anxiety/mood problems (Martel et al., 2010). Thus, the behavioral heterogeneity of children with ADHD may be well-captured by their dispositional trait profiles.

This study extends this limited prior work in two ways. It also examines whether the same groups found in school-age children with ADHD (i.e., low control, high surgency/extraversion, and high negative affect) can be identified in a preschool sample of children with ADHD. Second, the study examined whether these personality groups could be externally validated via ADHD and oppositional-defiant disorder (ODD) symptoms, comorbid psychopathology, executive function profiles, and the 6-month longitudinal course of ADHD and ODD symptoms. It was predicted that the low control group would exhibit higher initial and increasing longitudinal course of inattentive ADHD symptoms and worse executive function, the high surgency group would exhibit high initial and increasing longitudinal course of hyperactive-impulsive ADHD symptoms and increased comorbid disruptive behavior problems (e.g., aggression), and the high negative affect group would exhibit high initial and increasing longitudinal course of ODD symptoms and comorbid anxiety/mood problems.

Method

Participants

Overview—Participants were 109 young children (64% male; 36% ethnic minority) between the ages of 3 and 6 (*M* = 4.34 years, *SD* = 1.08) and their primary caregivers (see Table 1). Based on multistage and comprehensive diagnostic screening procedures, children were recruited into two groups: ADHD (*n* = 61) and non-ADHD children (*n* = 48). Of the children with ADHD, 29 met criteria for the ADHD-C subtype/presentation, 26 met criteria for the ADHD-PHI subtype/presentation, and 6 met criteria for the ADHD-PI subtype/presentation (3 of whom met criteria for the inattentive presentation [restrictive]; APA, 2000; www.dsm5.org). Forty-three children with ADHD met criteria for ODD, and 18 children without ADHD met criteria for ODD. The non-ADHD group included children with sub-threshold (i.e., 5 or fewer inattentive or hyperactive-impulsive) symptoms, consistent with research suggesting that ADHD may be better captured by continuous dimensions than categorical diagnosis (Haslam et al., 2006; Levy, Hay, McStephen, Wood, & Waldman, 1997). No siblings were included.

Recruitment and identification—Participants were recruited from the community primarily through two sets of direct mailings to families with children between the ages of 3 and 6, advertisements, and Internet postings; one mailing targeted all families with children aged 3 to 6, and the other mailing targeted families with children aged 3 to 6 with attention and/or disruptive behavior problems. After recruitment, families passed through a multigated screening process. An initial telephone screening was conducted 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.

During the second stage, parents and preschoolers attended a campus laboratory visit. Parents of children taking psycho-stimulant medication (less than 5% of sample) were asked to discontinue their children's medication for 24 to 48 hr prior to the visit. 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 semistructured diagnostic interview administered by a trained graduate student clinician. The K-DBDS demonstrates high test–retest reliability and high interrater reliability in the preschool population (Leblanc et al., 2008). Reliability of interviewer ratings was determined by blind ratings of interviews of each interviewer on 10% of families with acceptable interrater clinician agreement for ODD and ADHD symptoms ($r = .99$, $p < .001$; $r = 1.00$, $p < .001$, respectively).

Families were mailed teacher/caregiver questionnaires 1 week prior to the laboratory visit and instructed to provide the questionnaires to children's teacher and/or day care provider 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

disruptive behavior disorder (DBD) symptoms was obtained via report on the Disruptive Behavior Rating Scale (DBRS; Barkley & Murphy, 2006). Sixty-seven percent of available ratings were available from teachers with the remaining ratings completed by day care providers or babysitters. Response rate did not differ based on child DBD diagnostic group, $\chi^2(3) = .59$, $p = .9$. 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, blind to other performance measures and ratings, consistent with current best practice guidelines for current diagnosis using *DSM-IV-TR* criteria (Pelham, Fabiano, & Massetti, 2005).

At the third stage that occurred 6 months after the families' first appointments, the primary caregiver completed the K-DBDS a second time over the telephone with a trained staff person based on their child's behavior over the last 6 months. No families reported treatment changes between the initial appointment and the 6-month follow-up.

Measures

Symptom counts for ADHD and ODD—Parents and teachers/caregivers provided information on ADHD and ODD symptoms via the DBRS (Barkley & Murphy, 2006). Endorsed symptoms are summed within each diagnostic subdomain (i.e., ODD, ADHD, inattention, hyperactivity-impulsivity) to determine symptom counts. The DBRS has high internal consistency ranging from .78 to .96 in the preschool age range (Pelletier, Collett, Gimple, & Cowley, 2006). All scales for parent and teacher/caregiver report on the DBRS had high internal reliability (all αs > .92) in the current sample.

Temperament and personality 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), a questionnaire for use with preschoolers. Negative affect, surgency, and effortful control were measured using the scales suggested by Rothbart et al. (2001). Composite scale scores were 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.

To measure reactive control and the big five factors, an examiner completed the California Child Q-Sort (CCQ; Block, 2008; Block & Block, 1980) after a 3-hr laboratory visit. The reactive control scale developed by Eisenberg et al. (1996) and Eisenberg et al. (2005), and the big five-factor scales developed by John, Caspi, Robins, Moffitt, and Stouthamer-Loeber (1994), respectively, were utilized. Scale reliability ranges were adequate (α = .65-.86).

Comorbid psychopathology—Comorbid psychopathology was measured via parent and teacher/other caregiver report (when available, as described above) on the Child Behavior Checklist (CBCL) and Caregiver-Teacher Report Form (C-TRF) for ages 1.5 through 5 (Achenbach & Rescorla, 2000). This measure has well-established reliability and validity (Achenbach & Rescorla, 2000). The scales from the CBCL and C-TRF scales exhibited high internal consistency in our sample (α range = .96-.97). Raw scores on the aggression, anxiety/depression, and pervasive developmental disorder (PDD) scales were utilized.

Executive function—Selected executive function tasks assessing response inhibition, working memory, and set-shifting were utilized, based on their reliability, validity, and sensitivity in the preschool population (Garon, Bryson, & Smith, 2008; Isquith, Crawford, Espy, & Gioia, 2005; Wiebe, Espy, & Charak, 2008). Number of correctly identified stimuli divided by time to complete the second trial of the Shape School served as a measure of response inhibition (Espy, Bull, Martin, & Stroup, 2006). The total of correctly completed items for Backward Digit Span provided a measure of working memory (Garon et al., 2008). Number of errors made during Condition B of the preschool adaptation of the Trail-Making Task, TRAILS-P, served as a measure of set-shifting (Espy & Cwik, 2004).

Data Analysis

Missingness was minimal in this study, with the exception of teacher ratings on the DBRS. The missingness and non-normality of data (i.e., symptom counts) were addressed using robust full information maximum likelihood estimation (FIML; that is, direct fitting) in Mplus (Múthen & Múthen, 1998-2008), a method of directly fitting models to raw data without imputing data (McCartney, Burchinal, & Bub, 2006). Latent profile analysis models were conducted in Mplus. Model fit was compared using log likelihood, Akaike information criteria (AIC), Bayes information criteria (BIC), and entropy, as is recommended (Grant et al., 2006). Smaller values of log likelihood, AIC, and BIC indicate better fit to the data, and higher values of entropy reflect better distinctions between groups (Kline, 2005); BIC was prioritized as it performs best of the information criterion indices (Nylund, Asparouhov, & Muthen, 2007). External validation of the best-fitting profile solution was conducted using multivariate or repeated-measure general linear models (GLMs), followed by corrected post hoc analyses, which controlled for Type I error (Tabachnick & Fidell, 2007). Power analysis indicated that statistical power was adequate (.80) to detect a medium-size effect ($r = .25$) for the full sample.

Results

Descriptive Statistics

Child age and sex did not significantly differ between children with and without ADHD (all $p > .1$; Table 1). However, child ethnicity significantly differed between the groups ($p < .05$); there were more ethnic minorities within the ADHD group. Parent- and teacher-rated ADHD symptoms differed significantly in the expected direction between diagnostic groups (all $p < .05$; Table 1). Most temperament and personality traits also significantly differed between the diagnostic groups. Negative affect and surgency were significantly higher in children with ADHD ($p < .05$), whereas effortful control, agreeableness, and conscientiousness were all significantly lower in children with ADHD ($p < .05$; Table 1).

Latent Profile Analysis

Latent profile models containing one through seven profiles were fit to all traits to exhaust the available models. Eight-profile models (and above) would not converge and were judged unsuitable to the data. Significant improvements in fit occurred as the number of profiles increased up to five profiles at which point the BIC leveled off (Table 2). Thus, the five-profile model exhibited the lowest BIC and seemed to be the best-fitting model. Based on

descriptive statistics for the profiles (Table 3), Profile 1 (n = 15) was labeled “low control,” Profile 2 (n = 19) “high surgency,” Profile 3 (n = 52) “low neuroticism,” Profile 4 (n = 17) “high agreeableness,” and Profile 5 (n = 5) “high negative affect.” The percentage of children with ADHD significantly varied across the five profiles, $\chi^2(4) = 17.41$, $p = .002$ (Table 4); children in the low control, high surgency, and high negative affect profiles were particularly likely to be diagnosed with ADHD compared with the low neuroticism and high agreeableness profiles. Furthermore, the percentage of children with the ADHD-PI subtype of ADHD significantly varied across groups ($p = .04$) with a higher percentage in the high agreeableness profile.

External Validation of Profiles

The profiles were next externally validated via a series of multivariate GLMs that examined profile differences parent- and teacher-rated ADHD and ODD symptoms, comorbid psychopathology, and executive function, based on a subset of the sample with available data. The overall multivariate GLM model examining profile differences in parent- and teacher-rated ADHD and ODD symptoms was significant, $F(6, 36) = 3.85$, $p = .005$. Individual GLM identified significant profile differences in parent-rated hyperactive-impulsive symptoms, $F(4) = 3.04$, $p = .03$, teacher-rated hyperactive-impulsive symptoms, $F(4) = 3$, $p = .03$, and teacher-rated ODD symptoms, $F(4) = 3.32$, $p = .02$. Based on post hoc least significance difference (LSD) tests, the low control profile had significantly higher parent-rated hyperactivity-impulsivity compared with the high surgency profile, and both of these groups had significantly higher hyperactivity-impulsivity compared with the high agreeableness profile. For teacher-rated hyperactive-impulsive and oppositional-defiant symptoms, the low control and high surgency profiles had significantly increased symptoms compared with the high agreeableness profile.

The overall multivariate GLMs examining profile differences in parent-rated and teacher-rated comorbid psychopathology were also significant, $F(4, 100) = 10.09$, $p < .001$; $F(4, 20) = 7.41$, $p = .001$, respectively. Individual GLM indicated significant profile differences in parent-rated anxiety/depression, $F(4) = 9.59$, $p < .001$, aggression, $F(4) = 7.44$, $p < .001$, and PDD, $F(4) = 6.8$, $p < .001$. Based on post hoc tests, the high surgency group exhibited higher anxiety/depression compared with the low neuroticism and high agreeableness groups, and the low control and high surgency groups exhibited higher aggression and PDD compared with the low neuroticism and high agreeableness groups. Individual GLM indicated significant profile differences in teacher-rated aggression, $F(4) = 4.58$, $p = .009$, but not anxiety/depression, $F(4) = .68$, $p = .61$, or PDD, $F(4) = 2.02$, $p = .13$; the high surgency profile had significantly higher levels of aggression compared with all other profiles.

The overall multivariate GLM examining profile differences in executive function was significant, $F(4, 93) = 5.81$, $p < .001$. Individual GLM indicated significant profile differences in response inhibition, $F(4) = 4.06$, $p = .004$, set-shifting, $F(4) = 5.02$, $p = .001$, and working memory, $F(4) = 2.45$, $p = .05$. Based on post hoc LSD tests, the low control profile exhibited significantly worse response inhibition than the high surgency group, and both groups had significantly worse response inhibition than the low neuroticism and high

agreeableness profiles. The low control and high surgency profiles exhibited significantly worse set-shifting than the low neuroticism and high agreeableness profiles. The high surgency profile exhibited significantly worse working memory than the low neuroticism and high agree-ableness profiles.

The repeated-measures GLMs examining profile differences in 6-month change in parent-rated inattentive ADHD and conduct disorder (CD) symptoms were not significant: for inattention, $F(4, 28) = 1.43$, $p = .25$, for CD, $F(4, 27) = 1.56$, $p = .21$. The repeated-measures GLM examining profile differences in 6-month change in parent-rated hyperactive-impulsive ADHD symptoms was significant, $F(4, 28) = 4.08$, $p = .01$. Although children in the high surgency profile exhibited high levels of hyperactivity-impulsivity that increased slightly over 6 months, children in the low neuroticism profile exhibited moderate levels that increased slightly, and children in the high agreeableness profile exhibited moderate symptoms that decreased slightly. The repeated-measures GLM examining profile differences in 6-month change in parent-rated ODD symptoms was sig-ificant, $F(4, 28) = 2.71$, $p = .05$. Based on post hoc LSD tests, children in the high surgency profile exhibited clinically significant ODD symptoms that increased over 6 months, whereas children in the low neuroticism group exhibited more moderate ODD symptoms that declined. Thus, overall, the five profiles exhibited a somewhat differential pattern of external correlates in the domains of disruptive behavior symptoms and associated problems and change in ADHD and ODD symptoms over 6 months.

Discussion

This study investigated whether a person-centered approach using dispositional traits could be used to parse the heterogeneity of ADHD and be externally validated with ADHD and ODD symptoms, comorbid psychopathology, executive function, and the 6-month longitudinal course of ADHD and ODD symptoms. Based on latent profile analysis, five profiles were uncovered: low control, high surgency, low neuroticism, high agreeableness, and high negative affect. In line with study hypotheses, young children with ADHD appeared to fall primarily into three main groups: (a) low control, (b) high surgency, and (c) high negative affect. Furthermore, these three subgroups of ADHD were externally validated with ADHD and ODD symptoms, comorbid psychopathology, executive function, and 6-month longitudinal change in ADHD and ODD symptoms. The low control and high surgency groups exhibited increased parent- and teacher-rated hyperactive-impulsive and ODD symptoms. The high surgency group additionally exhibited higher levels of comorbid psychopathology, particularly aggression. Furthermore, although the low control group exhibited the worst response inhibition, the high surgency group exhibited the worst working memory, and both groups exhibited poorer set-shifting, compared with the other groups. Finally, the high surgency group exhibited high and increasing levels of hyperactivity-impulsivity and ODD symptoms over 6 months.

In line with study hypotheses and limited prior work (Martel et al., 2010; Nigg et al., 2004), children with ADHD could be subdivided into three groups: low control, high surgency, and high negative affect. Children with ADHD may arrive at the disorder via several different routes and developmental trajectories, in line with multiple pathway models to ADHD (e.g.,

E. J. S. Sonuga-Barke, 2005; Sonuga-Barke, Bitsakou, & Thompason, 2010). The results of this study suggest that most children with ADHD are characterized by either profiles of low control or high surgency and that only a very small subgroup of children with ADHD are characterized by high negative affect. This is also in line with prior work and clinical observations and research indicating that some children with ADHD are characterized by severe emotional dysregulation (Barkley & Fischer, 2010; Martel et al., 2010; Sobanski et al., 2010).

The groups also exhibited partially distinct profiles of executive function. The low control group exhibited the worst response inhibition. In contrast, the high surgency group exhibited the worst working memory. Low control and high surgency groups both exhibited poorer set-shifting compared with the other groups. Furthermore, the high surgency group appeared to be at particular risk for hyperactive-impulsive ADHD symptoms and ODD symptoms, as well as comorbid psychopathology, including anxiety/depression, pervasive developmental disorder symptomatology, and perhaps particularly aggression. In addition, the high surgency group exhibited increasing levels of hyperactivity-impulsivity and ODD symptoms over a 6-month period, suggesting that high surgency may be a particularly important early manifestation of latent vulnerability to ADHD and disruptive behaviors during the preschool period. As surgency can be reliably measured very early during development and exhibits prominent sex differences favoring boys as early as infancy, this suggests that high surgency may be an important early marker of ADHD and disruptive behavior problems. Therefore, early assessment of surgency in assessment batteries may be advantageous for identifying a group of young children at particular risk for ADHD and associated problems.

Current findings should be interpreted in light of a number of study limitations. The negative affect subgroup was too small to allow for group comparisons, although—at a descriptive level—this group seemed to exhibit higher levels of anxiety/depression, poor response inhibition and working memory, and decreases in all DBD symptom domains over 6 months. An important future direction will be to examine this subgroup in larger samples to see whether it exhibits its own specific pattern of external correlates. Another important future direction is to evaluate additional important external correlates of DBD (e.g., social impairment, peer interactions). It will also be important to evaluate whether these sub-groups exhibit distinct longitudinal profiles spanning longer periods than 6 months (e.g., 1 year, 2 years, etc.). A strength of this study was that it utilized a community-recruited sample that was overrecruited for DBD. However, results from this study should be replicated in other types of samples (e.g., general population, clinical) to assess generalizability.

This study evaluated a person-centered approach, dispositional trait approach, to parse the behavioral heterogeneity of ADHD. Young children with ADHD appeared to fall primarily into three main groups: (a) low control, (b) high surgency, and (c) high negative affect. These three subgroups of ADHD exhibit somewhat distinct external correlates. Although the low control and high surgency groups exhibited increased parent- and teacher-rated hyperactive-impulsive and ODD symptoms, as well as poor set-shifting, the low control group exhibited poor response inhibition and the high surgency group additionally exhibited higher levels of comorbid psychopathology, particularly aggression, poor working memory,

as well as high and increasing levels of hyperactivity-impulsivity and ODD symptoms over 6 months. Therefore, surgency may be a particularly important early marker of ADHD.

Acknowledgment

We are indebted to the families who made this study possible.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was supported by National Institute of Health and Human Development Grant 5R03 HD062599-02 to M. Martel.

Biography

Michelle M. Martel is an assistant professor at the University of Kentucky who conducts research on etiology and assessment of ADHD in children. She earned her PhD in clinical psychology at Michigan State University and is a licensed clinical psychologist.

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Table 1

Descriptive Statistics on Sample

	ADHD	Non-ADHD
	***n* = 61**	***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
Parent-rated inattention	14.62 (7.17)	5.49 (5.52)**
Parent-rated hyperactive-impulsive	18.08 (6.8)	6.82 (5.6)**
Teacher-rated inattention	19.04 (5.67)	4.05 (4.04)**
Teacher-rated hyperactive-impulsive	17.48 (6.15)	4.96 (4.98)**
Negative affect	4.68 (0.93)	3.69 (0.81)**
Surgency	4.96 (1.02)	4.5 (0.84)*
Effortful control	4.69 (0.87)	5.07 (0.87)*
Reactive control	4.47 (1.4)	4.9 (1.2)
Neuroticism	3.63 (1.30)	3.36 (0.92)
Extraversion	6.38 (1.69)	6.64 (1.09)
Openness	5.76 (1.26)	6.03 (1.07)
Agreeableness	5.34 (1.42)	6.52 (0.73)**
Conscientiousness	5.07 (1.18)	5.81 (0.94)**

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

* $p < .05$.

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

Table 2

Latent Profile Analysis Fit lndices

Profile	Log likelihood	AIC	BIC	Entropy
1-profile	−1,373.84	2,783.67	2,831.95	—
2-profile	−1,290.37	2,636.73	2,711.83	.83
3-profile	−1,263.95	2,603.91	2,705.83	.87
4-profile	−1,227.3	2,550.6	2,679.35	.85
5-profile	**−1,203.41**	**2,522.82**	**2,678.38**	**.86**
6-profile	−1,188.46	2,512.92	2,695.3	.87
7-profile	−1,181.61	2,519.23	2,728.43	.87

Note: AIC = Akaike's information criteria; BIC = Bayes information criteria. Boldface indicates the best-fitting model.

Table 3

Latent Profile Solutions Using Child Traits: Descriptive Statistics

Solution	*n*	NE	Sur	EC	RC	N	E	O	A	C
Five-profile solution										
Profile 1	15	4.47	5.23	**4.25**	4.42	4.62	5.68	4.75	4.53	4.19
Profile 2	19	4.6	**5.26**	4.92	2.73	3.39	**8.02**	5.89	4.53	4.13
Profile 3	52	4.09	4.64	4.94	4.78	**3.14**	7	6.19	6.46	5.78
Profile 4	17	3.82	4.34	5.1	5.99	3.25	5.29	6.26	**6.9**	6.48
Profile 5	5	**5.57**	3.73	4.67	6.99	**4.78**	3.05	5.1	5.81	6.57

Note: NE = negative emotionality; Sur = surgency; EC = effortful control; RC = reactive control; N = neuroticism; E = extraversion; O = openness; A = agreeableness; C = conscientiousness. Bold represents the best-fitting solution.

Table 4

External Validation: Five Profiles

	Low control	High surgency	Low neuroticism	High agreeableness	High negative affect
%ADHD	80	79	44	35	100***
%ADHD-C	33	37	27	6	40
%ADHD-PHI	47	42	12	12	60
%ADHD-PI	0	0	6	18	0***
%ADHD-RI	0	0	4	6	0
P inattention	12.6 (6.39)	14.79 (8.19)	9.26 (7.34)	9 (9.05)	9.5 (9.29)*
P hyper-imp	18.67 (6.14)a,c,d	18.16 (7.9)b,c,d	11.42 (7.78)a,b,c	8.06 (7.49)a,b,d	14.75 (10.37)***
P ODD	10.73 (7.52)	10.53 (8.41)	6.88 (5.83)	5.65 (4.7)	7.5 (5.26)*
T inattention	17.33 (7.06)	14.5 (4.51)	10.3 (8.58)	9.1 (10.73)	24.5 (3.54)*
T hyper-imp	17.33 (6.41)a	17.25 (6.34)b	9.96 (8.32)	7.1 (6.33)a,b	25 (2.83)***
T ODD	1 1.5 (6.83)a	12.75 (9.86)b	5.78 (5.8)a,b	3.1 (3.33)a,b	14 (0)***
P anxiety/depression	4 (0.64)	4.84 (0.57)a,b,c	2.9 (0.35)a,b	2.71 (0.6)a,c	10 (1.2)***
P aggression	20.67 (2.14)a,c,d	18.58 (1.9)b,c,d	10.7 (1.17) a,b,c	9.53 (2.01)a,b,d	19.25 (4.15)***
P PDD	6.47 (0.84)a,c,d	7.11 (0.75)b,c,d	4.08 (0.46)a,b,c	4.06 (0.79)a,b,d	10.5 (1.63)***
T anxiety/depression	2.33 (1.53)	3.5 (0.71)	2.67 (2.64)	5.17 (5.81)	1.5 (2.12)
T aggression	11.33 (6.66)a	39 (8.49)a,b,c,d	13.08 (11.78)b,c	6.33 (5.47)b,d	19 (1.41)**
T PDD	4 (1.73)	14.5 (0.71)	4.75 (4.41)	5.83 (6.31)	7 (4.24)
Response inhibition	0.43 (0.45)a,c	0.54 (0.32)b	0.75 (0.34)a,b	0.76 (0.37)a,c	1.04 (0.53)***
Set-shifting	74.49 (43.23)a	75.34 (41.54)b	36.45 (35.79)a,b	46.75 (40.7)a,b	44.67 (31.32)***
Working memory	1.07 (2.17)	0.18 (0.71)a,b,c	1.91 (2.27)a,b	2 (2.47)a,c	2 (2.83)**
Change in inattention	2-2.5	3.8-5.8	2.73-3.2	3.1-4.1	4-0
Change in hyper-imp	7-7	7.4-7.8a,b	4.07-4.4a,b,c	4.2-3.9a,c	8-0***
Change in ODD	6-3	5.2-5.4b	3.33-2.27b	3.4-2.8	6-0***
Change in CD	3-2	1.8-2	1.13-1.07	0.8-1.8	0-0

Note: ADHD-C = ADHD-combined subtype; ADHD-PHI = ADHD-predominantly hyperactive-impulsive subtype; ADHD-PI = ADHD-predominantly inattentive subtype; ADHD-RI = ADHD-Inattentive (restrictive) presentation; P = parent-rated; T = teacher-rated; hyper-imp = hyperactivity-impulsivity; ODD = oppositional-defiant disorder; PDD = pervasive developmental disorder; CD = conduct disorder Like superscripts indicate significant differences on least significance difference (LSD) post hoc comparisons.

* $p < .01$.

** $p < .05$.

*** $p < .01$ based on chi-square or GLM.