The Role of Temperament and Personality

in Problem Behaviors of Children with ADHD

Abstract

This study describes temperament, personality, and problem behaviors in children with Attention-Deficit Hyperactivity Disorder (ADHD) aged 6 to 14 years. It targets differences between an ADHD sample ($N = 54$; 43 boys) and a large community sample ($N = 465$; 393 boys) in means and variances, psychometric properties, and covariation between traits and internalizing and externalizing problems. Parents rated their children on Buss and Plomin's and Rothbart's temperament models, a child-oriented five-factor personality model and also on problem behavior. Relative to the comparison group, children with ADHD presented with a distinct trait profile exhibiting lower means on Effortful Control, Conscientiousness, Benevolence and Emotional Stability, higher means on Emotionality, Activity, and Negative Affect, but similar levels of Surgency, Shyness, and Extraversion. Striking similarities in variances, reliabilities and, in particular, of the covariation between trait and maladjustment variables corroborate the spectrum hypothesis and suggest that comparable processes regulate problem behavior in children with and without ADHD.

Keywords: temperament, personality, ADHD, spectrum hypothesis, children, problem behavior

Introduction

The behavioral disorder Attention-Deficit/Hyperactivity Disorder (ADHD) is defined by the presence of symptoms of inattention and hyperactivity-impulsivity, to a degree that is maladaptive and inconsistent with the developmental level (American Psychiatric Association [APA], 2000). ADHD symptoms surface early in life, have lifelong continuity and are increasingly acknowledged as domains that should be assessed dimensionally (Castellanos, 2009; Haslam et al., 2006). In line with the recognition of the trait-like nature of ADHD, scholars emphasize wide behavioral variability among individuals with ADHD, not only in symptom expression, but also in levels of adaptive functioning, psychiatric comorbidity, and the incidence of behavioral and emotional problems (Wilens, Biederman, & Spencer, 2002).

Theorists increasingly suggest that the study of temperament and personality traits could substantially improve our understanding of this broad heterogeneity within ADHD. Two particularly promising avenues have been pinpointed. First, traits are suggested to have *diagnostic relevance* because they broaden our understanding of current behavioral criteria and capture the heterogeneous ADHD symptom expression (Martel, 2009; Nigg, 2006; Nigg, Goldsmith, & Sachek, 2004; White, 1999). Second, trait variation is hypothesized to affect the development of maladaptive behaviors and hence could partially explain the varying levels of *problem behaviors* in individuals with ADHD (Nigg et al., 2004).

To date, empirical research has primarily addressed the first avenue by compiling distinct temperament or personality trait profiles associated with ADHD. Both in children (e.g., Bussing et al., 2003; Cukrowicz, Taylor, Schatschneider, & Iacono, 2006; Martel & Nigg, 2006; Rettew, Copeland, Stanger, & Hudziak, 2004) and in adults (e.g., Anckarsater et al., 2006; Faraone, Kunwar, Adamson, & Biederman, 2009; Miller, Miller, Newcorn, & Halperin, 2008; Nigg et al., 2002), this research identifies an ever increasing number of traits distinguishing individuals with ADHD from their typically developing peers.

Compared to this growing literature on mean-level differences, surprisingly little research has explored the second avenue, examining the role of trait variation in the expression of problem behaviors *within* groups of children with ADHD. This lack of studies might be related to the widespread conception that ADHD symptoms themselves belong to the group of externalizing (disruptive) behaviors (e.g., Oldehinkel, Hartman, De Winter, Veenstra, & Ormel, 2004). However, by definition, ADHD symptoms such as inattention, hyperactivity or impulsivity do not necessarily bring the child into conflict with others. While children with ADHD are definitely at increased risk for developing externalizing problems, they differ widely in frequency of rule-breaking, antisocial or aggressive behavior. Moreover, levels of experienced emotional problems also vary greatly among children with ADHD (Wilens et al., 2002). Although trait differences have been suggested to partly account for this wide variability (Nigg et al., 2004), empirical studies of trait-maladjustment relationships in children and youth with ADHD remain in short supply.

The present study empirically pursues both research avenues and targets differences between children with ADHD and children from a large community sample in temperament, personality and their associations with internalizing and externalizing problems. In addition, this dual approach systematically addresses two major issues currently hindering the expansion of trait research in ADHD by (a) assessing multiple temperament and personality constructs and (b) testing the viability of these concepts to the study of children with ADHD.

Simultaneous assessment of multiple temperament and personality models

A first issue that particularly impedes integration of research outcomes on traits in ADHD (e.g., Martel, 2009) is the use of different trait measures across studies. This methodological diversity results from discussions about the exact nature and number of dimensions underlying *temperament* - a term historically qualifying behavioral traits in children (Rothbart & Bates, 2006) - and also stems from the controversy on whether traits are

best viewed as temperament or *personality* - a term historically qualifying individual differences among adults (Caspi, Roberts, & Shiner, 2005). Recent theory and research now indicate that both temperament and personality systems provide valid and complementary languages to describe 'endogenous basic tendencies of thoughts, emotions, and behaviors', in children (Caspi et al., 2005; De Pauw, Mervielde, & Van Leeuwen, 2009) as well as in adults (Evans & Rothbart, 2007). Yet, the exact nature of convergence among these trait taxonomies remains unknown because empirical research comparing multiple trait models is lacking. Hence, integrating research findings across different frameworks is identified as one of the biggest challenges for modern trait research (Rettew & McKee, 2005; Tackett, 2006).

To enable the comparison of both common and model-specific effects, scholars now recommend the simultaneous administration of multiple trait measures, particularly when studying trait-maladjustment associations (De Pauw et al., 2009; Mervielde, De Clercq, De Fruyt, & Van Leeuwen, 2005; Tackett, 2006). Therefore, the current study simultaneously evaluates two prominent temperament models and one personality model. To assess *temperament*, we include both the model of Buss and Plomin (1984) distinguishing Emotionality, Activity, and Sociability (EAS) and the model of Rothbart (Putnam, Ellis, & Rothbart, 2001) postulating Negative Affect, Surgency, and Effortful Control as overarching temperament dimensions. These models complement each other in describing temperament as individual differences in reactivity and regulation. Within reactivity, affective traits (i.e., tendencies to experience distress, captured by traits like Emotionality and Negative Affect) are set apart from activational traits (i.e., motor activity, agency, and sociability). These activational traits are separately assessed by EAS-Activity and Sociability, but merged under Rothbart's Surgency. On the other hand, Effortful Control, the temperamental trait addressing attentional and impulse regulation, is only targeted by Rothbart's model. To measure childhood *personality*, we include the Hierarchical Personality Inventory for Children (HiPIC;

Mervielde & De Fruyt, 2002), an age-appropriate version of the Five-Factor Model (FFM) of personality, assessing Emotional Stability, Extraversion, Conscientiousness, Benevolence, and Imagination.

Compiling more comprehensive diagnostic trait profiles associated with ADHD

The comparison of the three trait models will generate more comprehensive and distinctive trait profiles associated with childhood ADHD than the ones linked to a single trait model. Although narrative reviews propose major roles for traits such as Effortful Control, Conscientiousness, Activity, and Emotionality to differentiate children with and without ADHD (De Pauw & Mervielde, 2010; Martel, 2009; Nigg, 2006; Nigg et al., 2004; White, 1999), empirical research examining the selected trait models in children diagnosed with ADHD is rather limited.

We found only a single study relying on Buss and Plomin's model (Finzi-Dottan, Manor, & Tyano, 2006) reporting parent-ratings of EAS-temperament for 65 children with ADHD (mean age 11) but without comparable data for a reference group. Notably, these EAS-scores did not differ from the scores of an age-appropriate normative sample ($n = 109$; Boer & Westenberg, 1994). Yet, when the 25 children with predominantly inattentive symptoms were excluded, the children with ADHD scored about half a standard deviation (SD) higher on Activity and Emotionality, but not on Sociability.

Two studies are informative regarding Rothbart's model. Cukrowicz et al. (2006) compared 88 children with a single diagnosis of ADHD with 1342 controls (mean age 11) on Tellegen (2000)'s Multidimensional Personality Ratings, an instrument assessing three dimensions similar to the ones proposed by Rothbart. In this study, parents rated children with ADHD, compared to controls, as about 1 SD lower on Constraint, ½ SD higher on Negative Emotionality, but as not different on Positive Emotionality. Analogous results are reported by Martel and Nigg (2006) who compared 107 children with ADHD and 72 controls (mean age

9.5) on the Effortful Control-scale of the Early Adolescent Temperament Questionnaire (Capaldi & Rothbart, 1992) and on the California Child Q-set (CCQ; Caspi et al., 1992). Again, major differences are evident for Effortful Control and CCQ-assessed Negative Emotionality, revealing that mothers rated children with ADHD more than 1½ SD lower on Effortful Control and about 1 SD higher on Negative Emotionality.

Recently, Martel, Nigg and Lucas (2008) calculated 'little five' personality proxies from the CCQ-set data (omitting Openness-to-experience), providing the first evidence on five-factor personality in children with ADHD. Compared to controls, children with ADHD score more than 1½ SD lower on Conscientiousness, more than ¾ SD lower on Agreeableness, more than ½ SD higher on Neuroticism, but did not differ on Extraversion.

Testing the spectrum hypothesis: How are traits related to problems in childhood ADHD?

This study goes beyond examining mean-level differences to explain behavioral heterogeneity among children with ADHD by assessing covariation between traits and problem behavior. The lack of studies examining covariation in ADHD stands in sharp contrast with the growing body of research on typically developing children, suggesting that trait factors substantially and differentially contribute to problem behavior. Research identifies Buss and Plomin's Emotionality as a major correlate of both internalizing and externalizing behavior, whereas higher levels of Activity and Shyness differentially predict externalizing versus internalizing problems (De Pauw et al., 2009; Gjone & Stevenson, 1997). Rothbart (2007) recently stated that each of her trait dimensions explains a significant part of internalizing and externalizing behavior. High Negative Affect strongly relates to both types of problems, higher Surgency relates to more externalizing and fewer internalizing problems, while lower Effortful Control is primarily linked with externalizing and more modestly with internalizing. Lastly, Mervielde et al. (2005) proposed the following links between five-factor personality and maladjustment: low Emotional Stability and Extraversion as typical correlates

of internalizing problems, low Benevolence and Conscientiousness as associated with externalizing behavior, and Imagination as unrelated to the prevalence of problems. Notably, these broadband trait-maladjustment associations are largely comparable to those documented in adult samples (e.g., Krueger, McGue, & Iacono, 2001).

One important and intriguing research question is to what extent these trait-maladjustment relationships are *similar* for children with ADHD and children from non-clinical community samples. This question poses a second, more fundamental challenge for current research assessing traits in ADHD: Inquiring to what extent temperament and personality, as viable concepts for the study of typical development, are relevant for the study of clinical syndromes such as ADHD. Although this concern has – to our knowledge – not yet been explicitly raised for ADHD, the generalizability has been assessed and debated for other clinical groups, both for adults and youngsters (De Pauw, Mervielde, Van Leeuwen, & De Clercq, in press; Eisenberg et al., 2010; O'Connor, 2002; Shiner & Caspi, 2003; Van Leeuwen, Mervielde, De Clercq, & De Fruyt, 2007).

The classic version of the *spectrum hypothesis* (Shiner & Caspi, 2003) postulates that differences between clinical and non-clinical samples are mainly *quantitative* (O'Connor, 2002; Van Leeuwen et al., 2007). This implies that differences between both types of samples are restricted to *mean-level differences*. Recently, Van Leeuwen et al. (2007) developed a hierarchical framework to examine whether differences between clinical and non-clinical samples could be considered as mainly *qualitative* or rather *quantitative*.

This framework provides a hierarchically organized set of extended tests of the spectrum hypothesis, going beyond mere assessment of mean-level differences. At Level 1, *means and variances* for relevant variables are compared for clinical and non-clinical groups. Level 2 comparisons target differences in *psychometric properties* such as reliability and factorial structure of measures, to certify the validity of the interpretation of any mean-level

between-group differences. Finally, a comprehensive test of the spectrum hypothesis should also assess the structure of the *nomological network* in clinical versus non-clinical samples with Level 3 analyses comparing the *covariation* between relevant variables in both samples.

If tests at each level reveal substantial differences, groups are definitely *qualitatively different* and in effect incomparable because differences in structure, reliability and the nomological network indicate that the same instrument behaves differently and has a distinct meaning in clinical versus non-clinical groups. By contrast, if all tests, except those for mean-mean-level effects, fail to show significant differences, a convincing case can be made for pure *quantitative* or spectrum-type differences between groups. Of course, most comparisons of groups will uncover a pattern of results that is located in between the opposite poles of this 'qualitative versus quantitative' continuum. In this respect, the successive levels can be seen as more stringent tests of the spectrum hypothesis. For instance, compliance with Level 2 or 3 tests presents a stronger case for spectrum-type differences between groups than the common exclusive focus on Level 1 mean-level differences.

Van Leeuwen et al. (2007) applied this framework to compare a heterogeneous sample of children referred for psychological counseling and therapy ($N = 205$) to a large non-referred community sample ($N = 596$) in terms of personality and problem behavior. Their study generally supported the spectrum hypothesis revealing mainly mean-level differences and few Level 2 or 3 differences. Although Level 3 analyses revealed similar patterns of covariation between traits and problem behavior, the strength of some covariations turned out to be stronger in the referred sample. The referred sample included few children diagnosed with ADHD and therefore these results cannot be generalized to children with and without ADHD. Moreover, the heterogeneous composition of the clinical sample may be partially responsible for the failure of Level 2 and 3 tests.

The present study

The present study adopts this recently developed approach to probe the nature of differences in temperament, personality and their associations with maladjustment between a rather homogeneous group of children with ADHD and a large comparison group. To this end, we implement the extended spectrum hypothesis tests, assessing group differences for means and variances (Level 1), reliability of measures (Level 2), and differences regarding trait-maladjustment covariations (Level 3). Based on previous research on diagnostic trait profiles in ADHD, we expect that substantial Level 1 mean differences will differentiate children with ADHD from the comparison sample. Based on the emergent but only partial empirical support for the spectrum hypothesis (based on heterogeneous referred and non-referred samples; Van Leeuwen et al., 2007), we hypothesize that no substantial differences will be found in Level 2 and Level 3 comparisons and hence, that differences between children with ADHD and comparison children will be limited to quantitative differences.

Method

Participants and procedure

An initial ADHD-referred sample of 84 children (mean age 10.61, SD = 2.5) was recruited from two ADHD service centers in Flanders, Belgium, subsidized by the Flemish government to provide information, assistance and counseling to persons with ADHD, their parents, teachers and families. Seventy-four families responded by phone or email to an announcement of this research posted in the newsletter and on the website of the first center. These families received our set of questionnaires by mail and 60 of them returned the stamped envelopes. Families receiving ADHD counseling from the second center were personally informed about the study by a research assistant. Of 40 eligible families enrolled in the center at that time, 24 mothers participated by completing and returning the questionnaires by mail. Mothers filled in the set of five questionnaires probing ADHD symptomatology, the two temperament models, five-factor personality and problem behavior in addition to a

demographic form supplying extra information about the disorder.

In both samples, eligible children were between 6 and 14 years (without severe cognitive, sensory, motor or medical conditions) who previously received a formal diagnosis of Attention-Deficit/Hyperactivity Disorder, based on DSM-IV-TR (APA, 2000) criteria. The inclusion criteria were verified by means of a short checklist administered by phone or email (first center) or by inspecting the diagnostic records of each client by the research assistant (second center), prior to enrollment in the study. Only children who were reported to be formally diagnosed by a child psychiatrist or pediatrician were included: 74 children were diagnosed by a child psychiatrist, while 10 children received the diagnosis from a pediatrician. These diagnoses (13 of the predominantly inattentive type, 71 of the predominantly hyperactive/impulsive type or combined type) were known for an average of 3.6 years (SD = 2.5). At the time of the study, 70 children used methylphenidate and 53 children (9 of them not using methylphenidate) received psychological and/or speech and language therapy services. The sample is predominantly male (sex ratio 5:1, 14 girls). Chi-square analyses revealed no differences in demographic variables, symptom severity, use of methylphenidate or treatment services between the two ADHD centers.

The comparison sample was extracted from a larger study ($N = 974$; 496 boys) on the relations between multiple temperament models, five-factor personality and child adjustment. Undergraduate psychology students individually recruited two families - within their own social environment, excluding first-grade family members - with a child between 6 and 14 years. The families were visited at home and completed the measures in the presence of the student. This sample was reduced by stratified random sampling of 500 children (75 girls; mean age 10.51, SD = 2.6 years) with a chronological age and gender distribution that closely matched the distributions within the ADHD sample. Each mother rated the child's problem behavior whereas temperament and personality questionnaires were equally and randomly

divided over mothers and fathers [1]. This research was approved by the local ethics committee and all participants enrolled in this study provided written informed consent.

Instruments

ADHD symptoms

Parents from the ADHD sample completed the Dutch version (Oosterlaan, Scheres, Antrop, Roeyers, & Sergeant, 2000) of the Disruptive Behavior Disorder Rating Scale (DBDRS; Pelham, Gnagy, Greenslade, & Milich, 1992), consisting of 42 items, each rated on a 4-point Likert scale. This measure probes symptoms according to DSM-IV criteria in four domains: inattention, hyperactivity-impulsivity, oppositional defiant disorder, and conduct disorder. Adequate internal consistencies are found in this study, with α's of .87, .89, .90, and .76 for the four scales respectively.

Temperament models

All parents completed the EAS Temperament Survey (Buss & Plomin, 1984; Dutch version; Boer & Westenberg, 1994) and the Early Adolescent Temperament Questionnaire – Revised (EATQ-R; Ellis & Rothbart, 2001; Dutch version; Hartman, 2000). The EAS comprises 15 items that are rated on a 5-point Likert scale, assessing the three Buss and Plomin dimensions Emotionality, Activity, and Sociability. Sociability-items of this 15-item version of the EAS, primarily probe feelings of discomfort in social situations and hence their content is best captured by the label Shyness (Boer & Westenberg, 1994). The 62 EATQ-R items are rated on a 5-point Likert scale and are assembled in two behavioral (not considered in this study) and eight temperament scales, reflecting the Rothbart dimensions of Negative Affect (combining the subscales Fear, Frustration), Surgency (High-Intensity Pleasure, Shyness), and Effortful Control (Activation Control, Attention, Inhibitory Control). In addition, the EATQ-R Affiliation scale taps the desire for warmth and closeness to others, which is theoretically assumed to be a fourth domain, independent from the three other

broadband domains (Rothbart, 2007). However, this proposition received only limited empirical support by factor-analytic work on the EATQ-R (Ellis & Rothbart, 2001; Muris & Meesters, 2009). As a result, we regard Affiliation solely as a lower-order scale in this study [2].

Five-Factor personality

Parents also completed the Hierarchical Personality Inventory for Children (HiPIC; Mervielde & De Fruyt, 2002). The HiPIC comprises 144 items rated on 5-point Likert scales, assessing 18 facets hierarchically organized under five higher-order dimensions that are conceptually and empirically related to the adult FFM-domains: Emotional Stability (comprising the facets Anxiety and Self-confidence), Extraversion (Shyness, Optimism, Expressiveness, and Energy), Conscientiousness (Achievement Motivation, Concentration, Perseverance, and Orderliness), Benevolence (Egocentrism, Irritability, Compliance, Dominance, and Altruism), and Imagination (including Creativity, Curiosity, and Intellect).

Problem behaviors

In both samples, mothers completed the Child Behavior Checklist (Achenbach & Rescorla, 2000; Verhulst & Van der Ende, 2001) to rate on 3-point Likert scales the prevalence - over the past 6-month period - of 120 maladaptive behaviors. The two correlated broadband domains Internalizing and Externalizing are used to measure emotional symptoms and antisocial/conduct problems respectively. The Internalizing problems scale combines the three lower-order scales of anxious/depressed, withdrawn/depressed and somatic complaints, whereas the Externalizing problems scale aggregates the two syndrome scales of aggressive and rule-breaking behaviors. In addition, scores on the attention problems syndrome scale (10 items) and on the DSM-oriented scale of attention-deficit/hyperactivity problems (7 items) are examined to check for elevated levels of typical ADHD behaviors in the comparison sample.

Creating less heterogeneous clinical and non-clinical groups

Because large heterogeneity within groups could bias the results in support of the

spectrum hypothesis, we increased the power of the study by selecting a more homogeneous ADHD and comparison group. All children who did not meet clinical elevations on DBDRS-ratings of inattention and hyperactivity were omitted ($N = 30$) from the ADHD sample. According to Flemish norms (Oosterlaan et al., 2000), 45 of the 84 originally identified children scored above the clinical threshold for inattention symptoms while 41 of the original group surpassed the clinical threshold for hyperactivity symptoms. Fifty-four children were hence identified as exceeding the clinical threshold on inattention and/or hyperactivity symptoms. Only these 54 children were retained as ADHD sample for the present study.

In addition, all children from the comparison sample with elevated scores on ADHD proxy scales of the CBCL were omitted ($N = 35$). To identify these children, DBDRS-scores were regressed on the CBCL Attention Problems scale and DSM-oriented ADHD scale in the original ADHD sample to determine CBCL cutoffs associated with subclinical elevations on the DBDRS. Respectively 10 boys and 4 girls from the comparison group scored above these cutoffs and were consequently excluded from the comparison group. In addition, scores of the comparison group were contrasted with recently developed Flemish norms on the CBCL Attention Problems scale (Braet, Callens, Schittekatte, Soyez, & Roeyers, revision submitted). Relative to these age- and gender-appropriate norms, an additional 20 boys and 1 girl showed subclinical elevations and were also excluded from the comparison group.

This procedure hence resulted in the comparison of 54 children with ADHD with 465 children from the general community. All these children were Caucasian and no significant differences were found in demographic variables including age, years of parental education, and occupational status. Children in both the ADHD and comparison sample were on average 10.4 years (SD = 2.5), mothers were on average 39.7 years (SD = 5.0), while fathers were on average 41.8 years (SD = 5.7). All mothers had an average of 13.7 years (SD = 2.1) of education whereas fathers received on average 13.5 years (SD = 2.3) of education. In both

samples, 90% of the mothers and 96% of the fathers were employed.

Statistical analyses

The extended spectrum hypothesis tests included the following group-level comparisons. At Level 1, univariate ANOVA's were used to examine *mean-level* differences in problem behavior, temperament, and personality while Levene's homogeneity of variances tests were carried out to check for variance differences. Level 2 analyses included the computation and comparison of *reliability* estimates and their 95% confidence intervals for each instrument in both groups, as proposed by Fan and Thompson (2001). Level 3 analyses, comparing the *nomological network* of variables in children with ADHD to that in the comparison sample, followed a two-stage process. In a preliminary stage, differences *across* groups were explored by means of pairwise comparisons of the magnitude of bivariate correlations between temperament, personality, and problem behavior dimensions *within* each group, after Fisher *r* to *z* transformation. However, the large number of comparisons made this stage vulnerable to chance capitalization. Therefore, hierarchical multiple regression analyses (HMRA) were conducted to further examine the independent contributions of group versus temperament or personality variables to problem behavior and to test for differences in trait-maladjustment relationships between children with ADHD and the comparison group.

Separate HMRAs were conducted with temperament or personality as independents, and internalizing versus externalizing problems as dependents. Gender and age were entered in Step 1 as control variables. In Step 2, main effects for group and trait were calculated by entering the variable 'group' and one of the six temperament domains (Emotionality, Activity, Shyness, Negative Affect, Effortful Control, or Surgency) for the temperament analyses or one of the FFM-dimensions (Emotional Stability, Extraversion, Imagination, Benevolence or Conscientiousness) for the personality analyses. In Step 3, temperament-by-group and personality-by-group interactions were entered. As recommended by Aiken and West (1991,

p. 44), all variables were standardized to permit an appropriate solution with multiplicative terms. Given the lack of theoretical grounds for trait-by-group interactions, a step-down process dropping non-significant Step 3-interactions (Aiken & West, 1991, p. 105) was applied. In these cases, estimated Step 2-effects were reported. Significant interactions were plotted and interpreted following Aiken and West (1991). To correct for multiple statistical tests, a conservative significance level of $p \leq .01$ is adopted for all analyses in this study.

Results

Level 1: Group differences in means and variances

As expected and in line with the spectrum hypothesis, substantial mean group differences (summarized in Table 1) are found. Children with ADHD exhibit significantly more externalizing and internalizing problems but also present with trait profiles clearly deviating from the comparison group profile. On temperament, children with ADHD were rated with markedly lower levels of Effortful Control, $\eta_p^2 = .30$, than community children, while more modest effect sizes suggest higher levels of Emotionality, $\eta_p^2 = .12$, Activity, $\eta_p^2 = .09$, and Negative Affect, $\eta_p^2 = .07$, for the ADHD group. Notably, both groups did not differ on Shyness and Surgency. For personality, children with ADHD also scored lower than the comparison group on four of the five traits, but they did not differ on Extraversion. Effect sizes are particularly large for Conscientiousness, $\eta_p^2 = .25$, and Benevolence, $\eta_p^2 = .22$, moderate for Emotional Stability, $\eta_p^2 = .12$, and only modest for Imagination, $\eta_p^2 = .04$. Quantification of the effect sizes with Cohen's d estimates the group differences between ADHD and non-ADHD children as more than 2 SD on Effortful Control, more than 1 ½ SD on Conscientiousness and Benevolence, more than 1 SD on Emotionality, Emotional Stability, and Activity and more than ½ SD on Negative Affect and Imagination.

These results are also corroborated at the more fine-grained facet level [3], with the largest between-group differences found for the Conscientiousness facet Concentration, $d = $ -

2.17, and the Effortful Control facet Attention, $d = -2.08$, followed by Benevolence facets Compliance, $d = -1.79$, and Irritability, $d = 1.79$, and the Effortful Control facets Inhibitory Control, $d = -1.73$, and Activational Control, $d = -1.70$. The smallest differences are found for temperamental Affiliation, $d = -.56$, and the Imagination personality facet Curiosity, $d = -.37$. No statistical differences were found in the temperamental Negative Affect facet Fear, $d = .31$, and the Imagination personality facet Creativity, $d = -.29$.

Tests of homogeneity of *variances* reveal that, compared to the comparison group, ADHD children show substantially more variability in internalizing and externalizing behavior but only limited differences in variability of temperament and personality trait expression. The variance in Effortful Control was substantially *lower* in children with ADHD than in the comparison group, while the variance of temperamental Negative Affect and Shyness was moderately *larger* within the ADHD group. The relatively small magnitude of these variance differences however did not infringe ANOVA assumptions.

Level 2: Group differences in psychometric properties

Level 2 estimates of reliabilities are shown in the right panel of Table 1. The Cronbach's alpha's for the CBCL, temperament, and personality scales demonstrated acceptable to high levels of internal consistency, ranging from .68 (EATQ-R Effortful Control, ADHD group) to .95 (HiPIC-Conscientiousness, comparison group). Inspection of the confidence intervals reveals *overall similarity* in reliability, as confidence boundaries of both groups overlap for 10 of the 13 variables. Although all coefficients are deemed as satisfactory, the confidence intervals failed to overlap in three cases, indicating that reliability in the ADHD group is significantly lower than in the comparison group for EATQ-R Effortful Control and HiPIC Conscientiousness but significantly higher for EAS Activity.

Level 3: Group differences in trait-maladjustment covariation

Remarkable consistency is also found for the Level 3 analyses exploring differences in

bivariate *correlations* between temperament, personality and problem behavior variables. Only 7 out of 78 possible relationships turned out to be significantly different in the ADHD and the comparison group. Results of the HMRA, providing more extensive comparisons of the consistency of temperament (left panel) and personality (right panel) effects on internalizing and externalizing problems across groups, are presented in Table 2.

As anticipated, Step 2-analyses reveal major main effects for *group membership*, indicating that, relative to the comparison group, children with ADHD are at increased risk for both internalizing and externalizing problems. Moreover, Step 2 analyses reveal important independent effects for *temperament* as well as *personality* traits. Most importantly, Step 3 shows that 17 out of the 22 potential *trait-by-group interactions* are not significant, indicating that most temperament or personality effects are similar for children with ADHD and typically developing children. Regardless of group, the temperament traits Emotionality, Negative Affect predict both internalizing and externalizing problems, Shyness and Surgency are the major correlates of internalizing, whereas Activity and Effortful Control are primarily related to externalizing behaviors. For personality, we find that lower levels of Emotional Stability and Extraversion best predict internalizing, while low levels of Benevolence and Conscientiousness are the most powerful correlates of externalizing problems. These links are not fully exclusive because Emotional Stability and Benevolence also moderately contribute to externalizing and internalizing problems. The results suggest that the personality model is the better predictor of problems, as personality - in combination with group - explains up to 44 (Emotional Stability) and 58 (Benevolence) percent of the variance whereas temperament explains up to 36 (Negative Affect) and 45 (Emotionality) percent of internalizing and externalizing problem behavior variance respectively.

Although most trait effects are found to be consistent across both groups, Step 3 analyses identified four temperament-by-group interactions and one personality-by-group

interaction which are plotted in Figure 1. Three interactions indicate group-dependent effects for externalizing problems (left panel), while two interactions predict internalizing problems (right panel). The slopes of the regression lines of interactions (b), (c), and (d) are all significant at $p < .001$, both for the ADHD and comparison sample, confirming the highly similar shapes of the regression lines. This reveals that, across all children, lower levels of Effortful Control and Benevolence go together with more externalizing problems while higher levels of Negative Affect predict more internalizing problems, but that these covariations are significantly stronger in the ADHD group. Interaction (e) shows a similar pattern, indicating that all children with lower levels of Effortful Control are at increased risk for developing internalizing problems, although this covariation is more pronounced in the ADHD group, $t(52) = -4.96$, $p < .001$, than in the comparison group, $t(463) = -2.48$, $p = .014$.

Only interaction (a) suggests an ADHD-specific trait-maladjustment covariation. This interaction presents Shyness as a predictor of externalizing problems in the ADHD group, $t(52) = 4.36$, $p < .001$, but not in the comparison group, $t(463) = 0.23$, $p = .822$, revealing that children with ADHD rated with higher levels of shy behavior present significantly more externalizing problems [4].

<center>Discussion</center>

This study compiled comprehensive trait profiles and examined how traits are related to problem behavior in children with ADHD. This was accomplished by implementing tests for the 'extended spectrum hypothesis' (Van Leeuwen et al., 2007) targeting differences between children with ADHD and a large comparison sample in terms of problem behavior and a broad set of traits, including the Buss-Plomin and Rothbart temperament models and the Five-Factor personality model. Group differences on these variables were assessed at three distinct levels: means and variances (Level 1), reliability of measures (Level 2), and differences in trait-maladjustment covariation (Level 3).

Evidence for the spectrum hypothesis

The study revealed substantial Level 1 mean differences between the ADHD and comparison group but only limited differences for Level 2 psychometric properties and Level 3 comparisons regarding the nomological network. The absence of major Level 2 and Level 3 effects suggests that differences between children with and without ADHD can be conceived as quantitative rather than qualitative, because they are mainly confined to mean-level differences. Notably, these results are similar to the Van Leeuwen et al. (2007) comparison of a heterogeneous clinical sample (including few children with ADHD) with a non-referred community sample. This supports the spectrum hypothesis (Shiner & Caspi, 2003) for a more homogeneous clinical group of children with ADHD, and hence reveals that ADHD and non-ADHD samples can be located on the same set of continuous variables as partially overlapping distributions with a different mean. Analyses at the successive levels further demonstrate the utility of a trait approach in broadening our understanding of the varying phenotypical expressions of ADHD.

A more comprehensive diagnostic trait profile for children with ADHD

At Level 1, the simultaneous assessment of three adaptive trait measures uncovers a comprehensive *mean-level* profile associated with childhood ADHD. In line with previous research on the Rothbart model and five-factor personality in children with ADHD (Cukrowicz et al., 2006; Martel & Nigg, 2006; Martel et al., 2008), the largest differences from the comparison group are for Effortful Control and Conscientiousness, with particularly low scores on the facets Concentration and Attention (more than 2 SD) and on the facets Inhibitory and Activation Control (more than 1½ SD). In contrast with previous research based on the Buss-Plomin model (Finzi-Dottan et al., 2006), we also find that children with ADHD were rated more than 1 SD higher on Activity than community children. These trait differences show notable correspondences to the core ADHD symptoms of inattention,

impulsivity and hyperactivity, hence supporting the suggestion that traits are useful in partly capturing the heterogeneous ADHD symptom expression (Martel, 2009; Nigg et al., 2004).

Moreover, children with ADHD present with substantially lower Benevolence (more than 1½ SD) and Emotional Stability (more than 1 SD) in personality and higher (about 1 SD) Emotionality and Negative Affect in temperament. Facet analyses reveal particularly higher irritability, lower compliance and self-confidence, moderately more frustration and anxiety, but similar levels of fear. These results portray children with ADHD as being more difficult to manage because of frequent non-compliance and lower anger and temper control. In addition, children with ADHD tend to experience more emotional distress and lower self-reliance, even though they are not particularly fearful individuals. Children with ADHD also score about ½ SD lower on Imagination than comparison children, in particularly on the Intellect facet.

Contrary to the popular belief that children with ADHD are more 'extraverted', this study confirms previous research (Cukrowicz et al., 2006; Finzi-Dottan et al., 2006; Martel & Nigg, 2006; Martel et al., 2008) showing that children with ADHD do not differ from comparison children in Shyness, Extraversion, and Surgency. Theoretically, these traits are conceived as 'activational', incorporating both positive emotions and an energetic approach to the social and material world (Rothbart & Bates, 2006) and traditionally combine both activity and sociability-related scales. However, our results suggest that activity and sociability are differentially expressed in children with ADHD as they differ in energetic levels of motor activity, but not in shyness, gregariousness or expressiveness. As such, these findings emphasize the usefulness of separating activity- from sociability-content when studying childhood traits (Buss & Plomin, 1984; De Pauw et al., 2009).

Level 1 *variance* analyses further reveal similar variability among the ADHD and comparison group in their expression of most personality and temperament traits, although more restricted variances in Effortful Control but larger variance in Shyness and Negative

Affect were noted. These findings imply important individual differences among children with ADHD in terms of temperament and personality and hence caution against stereotyping based on mean-level profiles. From this perspective, trait information might lead to a better appreciation of particular strengths and vulnerabilities of the individual diagnosed with ADHD and hence facilitate selection and tailoring of treatments commensurate with the basic tendencies of each child.

Complementarity of temperament and personality models

Level 2 analyses also support the applicability of a trait approach to ADHD, as acceptable to high reliabilities are found for each instrument in each group and no substantial group differences emerged. These analyses corroborate the accumulating evidence (e.g., Caspi & Shiner, 2006; De Pauw et al., 2009; De Pauw et al., in press; Tackett, 2006) that both Buss-Plomin and Rothbart temperament models as well as Five-Factor based personality are reliable and valid languages to describe traits in childhood. Nevertheless, both Level 1 and Level 3 comparisons point towards both similarities and differences among trait 'languages', for example in how each trait model is associated with adjustment problems. This indicates that the three models are neither completely redundant nor totally independent: they share some variance but complement each other as measures of individual differences and as correlates of problem behavior. These model-specific differences caution against assimilating findings solely based on semantic similarity.

Trait-maladjustment relationships in children with ADHD and comparison children

Finally, Level 3 analyses demonstrate that the *nomological network* of trait-maladjustment relationships is *highly similar* across children with ADHD and the comparison group. Regression analyses reveal major group effects, showing that children with ADHD, as a group, are at increased risk for externalizing and internalizing problems, but moreover point towards strong independent contributions of temperament and personality. As such, this study

is one of the first that empirically supports the suggestion that trait variation helps to explain the varying levels of problems expressed by children with ADHD (Nigg et al., 2004).

As only five out of 22 trait-by-group interactions are significant, temperament and personality effects are largely consistent across the two groups and generally corroborate the patterns of specificity typically reported by research on trait-maladjustment covariations in non-clinical groups (e.g., De Pauw et al., 2009; Gjone & Stevenson, 1997; Mervielde et al., 2005; Rothbart, 2007). For temperament, higher levels of Emotionality and Negative Affect and lower levels of Effortful Control predict both internalizing and externalizing. Shyness and Surgency are primarily related to internalizing, whereas Activity mainly predicts externalizing problems. Personality shows a slightly more differentiated pattern and explains more variance than temperament. Lower Emotional Stability and Extraversion (and to a lesser degree, Benevolence) predict internalizing, while lower Benevolence and Conscientiousness (and to a lesser extent, Emotional Stability) are linked to externalizing problems.

Although in a strict sense, the sparse trait-by-group interactions are deviations from the extended spectrum hypothesis, four out of five pertain to the strength and not to the kind of relationship as indicated by similarly shaped regression lines in both samples. These interactions point towards stronger trait-maladjustment covariation in the ADHD group and hence only designate quantitative differences. Similar effects were noted by Van Leeuwen et al. (2007) and are presumably related to the 'clinical' nature of the ADHD group.

This overall similarity in trait-maladjustment covariations suggests that similar processes link traits to psychosocial functioning for individuals with ADHD and for comparison group children and implies that traits are an additional tool to identify ADHD children at risk for developing emotional or behavioral problems. Moreover, the substantial evidence for the extended spectrum hypothesis supports the application of trait-based interventions to children with ADHD, although many more studies are needed to explore and

evaluate trait-based interventions. Programs developed to increase Effortful Control (e.g., Rothbart, 2007) or trait-focused parent training (Sheeber & Johnson, 1994) for typically developing children may therefore turn out to be also beneficial for children with ADHD.

Interestingly, we detected one ADHD-specific trait-by-group interaction, suggesting that higher levels of Shyness go together with more externalizing problems in children with ADHD but not in comparison children. This effect was consistently found in regressions including the Shyness scales from the EAS, EATQ-R, and the HiPIC. Analyses at the item level show particularly high correlations in the ADHD group with items such as 'does not know how to behave in social situations', 'does not make friends easily', and 'is not very sociable', whereas correlations with 'pure' shyness-content such as 'tends to be shy' or 'withdraws into him/herself' are continually near zero. Hence, this effect appears primarily related to feelings of discomfort and clumsiness in social situations rather than to shy or withdrawn behaviors. This uneasiness in social contacts might directly relate to impairments in social skills, exhibited by many (but not all) children with ADHD, and hence information on this trait might help to decide whether or not a child with ADHD would benefit from social skills training (e.g., Pfiffner & McBurnett, 1997) in order to avert externalizing problems.

Limitations and Future Directions

Our findings should be interpreted in light of some limitations. First, although the present combination of the ADHD and comparison group provided adequate power for detecting Level 2 differences in reliabilities and Level 3 trait-by-group interactions, the limited sample size of the ADHD group did not allow for more in-depth, multi-group comparisons depending on structural equation modeling techniques. Future research with a larger clinical group could enhance Level 2 analyses by conducting tests for invariance of factorial structure. Similarly, Level 3 analyses could be enhanced by multi-group structural equation modeling, contrasting the fit of a model with and without group differences. Second,

the present study primarily relies on measures completed by the same informant, introducing shared method-variance. Relying on the parent as the sole informant might also result in potential bias, because parents of referred children may tend to exaggerate the problems of their own child. Given that ADHD often interferes with academic and intrapersonal functioning, comparing the parent trait profiles with teacher ratings in addition to children's self reports of traits and behavior would hence be interesting. Replication of findings with alternative measures and methods (e.g., observational assessment of traits, clinical ratings of psychopathology) is also warranted. Third, the present study is based on clinical judgment for ADHD diagnosis and on only limited information about psychosocial functioning. Clinical interviews permit stronger verification of the categorical ADHD status and differential trait profiles for ADHD subtypes and, in addition, assessment of comorbidity. Future research might further pursue the relevance of traits for differentiating these categorical conditions. However, in line with the growing recognition that ADHD is a clinically heterogeneous disorder, the present study provides dimensional assessment of how traits relate to maladjustment within a group of children currently receiving support to cope with ADHD. This allows a wider scope in evaluating aggressive or defiant behaviors and emotional disturbances instead of the traditional narrow focus on the more severe but less prevalent comorbid conditions such as Oppositional Defiant Disorder, Conduct Disorder or Major Depressive Disorder. Yet, the conclusions on trait-maladjustment relationships are not conclusive because of the cross-sectional nature of this study. Future research should investigate longitudinally the pattern of associations and address the underlying processes by which temperament and personality influence children's outcomes. Fourth, no data were available on those families contacted by the ADHD centers who did not choose to participate in the study. Finally, we acknowledge that childhood traits are only one of the many factors related to transactional processes that contribute to the development of problem behaviors.

Future research should therefore explicitly test the relative role of traits compared to other variables such as parenting (e.g., Van Leeuwen et al., 2007), both in ADHD and in typical development.

In conclusion, this study offers a comprehensive account of the role of traits in a sizeable sample of children with ADHD compared to children from a large general community sample. The analysis of group differences reveals important mean-level differences. In addition, a series of extended tests corroborate the spectrum hypothesis because the observed similarities between both groups and in particular the similarity of the nomological network suggest comparable links between traits and maladjustment in children with ADHD and typically developing children. These findings substantiate the value of a trait approach to ADHD, assessing both temperament and personality traits, to predict and explain varying levels of problem behaviors in children with ADHD.

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Notes

1. To reduce questionnaire load and informant bias in the comparison group, the EAS temperament measure and the HiPIC personality questionnaire were always completed by two different caregivers while the Rothbart temperament and the HiPIC personality instrument were independently completed by two different caregivers in 50% of the cases ($N = 250$). For the other 50% of the data, a single informant completed both the Rothbart and the HiPIC measure (25% mothers, 25% fathers). Analyses of variance revealed no significant mean differences ($p < .05$) between mothers and fathers for HiPIC-personality. Three significant temperament differences were registered: fathers rated their child higher on EAS Emotionality ($F(1, 498) = 18.01$, $p < .001$), Rothbart Negative Affect ($F(1, 498) =14.59$, $p < .001$) and also on EAS Activity ($F(1, 498) = 5.62$, $p < .05$).

2. Although the EATQ-R was originally developed for children aged 8 and beyond, we also administered this measure to parents of children below age 8 (15% of the sample) because we could not identify an adequate Flemish measure to assess psychobiological temperament for this age group. In both the ADHD and comparison sample, acceptable reliabilities are found for the three Rothbart domains in children below age 8, hence validating post hoc the choice of this measure.

3. Reports of the facet analyses are available upon request from the first author.

4. The Shyness-by-group interaction predicting externalizing problems is also documented by two subsequent HMRA's including the lower-order Shyness scale of the EATQ-R and the HiPIC, substantiating that higher scores on all included Shyness-scales predict more externalizing problems in children with ADHD but not in the comparison group.

Table 1. Group differences in means and variances (Level 1) and in reliability of measures (Level 2) for trait and problem behavior variables

| | Level 1 analyses | | | | | | | | Level 2 analyses | | | | |
| | ADHD | | Comparison | | | | | | # | ADHD | | Comparison | |
	M	SD	M	SD	F	η_p^2	d	$Levene$	items	α	95% CI	α	95% CI
Problem behaviors													
CBCL-externalizing	21.52	9.92	6.50	5.92	262.65**	.34	2.33	44.39**	35	.89	(.85, .93)	.86	(.84, .88)
CBCL-internalizing	14.48	7.90	5.02	5.03	148.70**	.22	1.75	16.00**	32	.83	(.76, .89)	.84	(.82, .86)
Temperament													
EATQ-R-Effortful Control	2.15	.37	3.37	.58	225.98**	.30	-2.17	14.73**	18	.68	(.54, .79)*	.87	(.84, .89)*
EAS-Emotionality	3.50	.92	2.58	.75	67.57**	.12	1.20	6.40	5	.85	(.78, .91)	.79	(.76, .82)
EAS-Activity	4.12	.88	3.37	.70	51.01**	.09	1.04	5.41	5	.85	(.77, .90)*	.72	(.68, .76)*
EATQ-R-Negative Affect	2.99	.74	2.47	.58	35.97**	.07	.87	7.54*	12	.84	(.77, .90)	.78	(.74, .81)
EAS-Shyness	2.32	.84	2.18	.68	2.03	.00	.20	7.13*	5	.80	(.70, .87)	.74	(.70, .78)
EATQ-R-Surgency	3.59	.69	3.46	.62	1.93	.00	.21	.90	14	.83	(.76, .89)	.81	(.78, .84)
Personality													
HiPIC-Conscientiousness	2.17	.47	3.27	.60	171.24**	.25	-1.87	2.86	32	.87	(.82, .92)*	.95	(.93, .95)*
HiPIC-Benevolence	2.65	.56	3.54	.51	145.09**	.22	-1.73	3.20	40	.93	(.91, .96)	.94	(.93, .95)
HiPIC-Emotional Stability	2.76	.68	3.48	.60	68.31**	.12	-1.18	.77	16	.86	(.80, .91)	.88	(.86, .89)
HiPIC-Imagination	3.41	.62	3.80	.54	23.84**	.04	-.71	1.86	24	.89	(.84, .93)	.91	(.90, .92)
HiPIC-Extraversion	3.53	.57	3.64	.51	2.21	.00	-.21	.78	32	.90	(.86, .94)	.91	(.90, .92)

Note. . * $p \leq .01$, ** $p \leq .001$. Scales are ordered by decreasing magnitude of η_p^2.

Table 2. Level 3 analyses of differences in trait-maladjustment covariation accounting for group
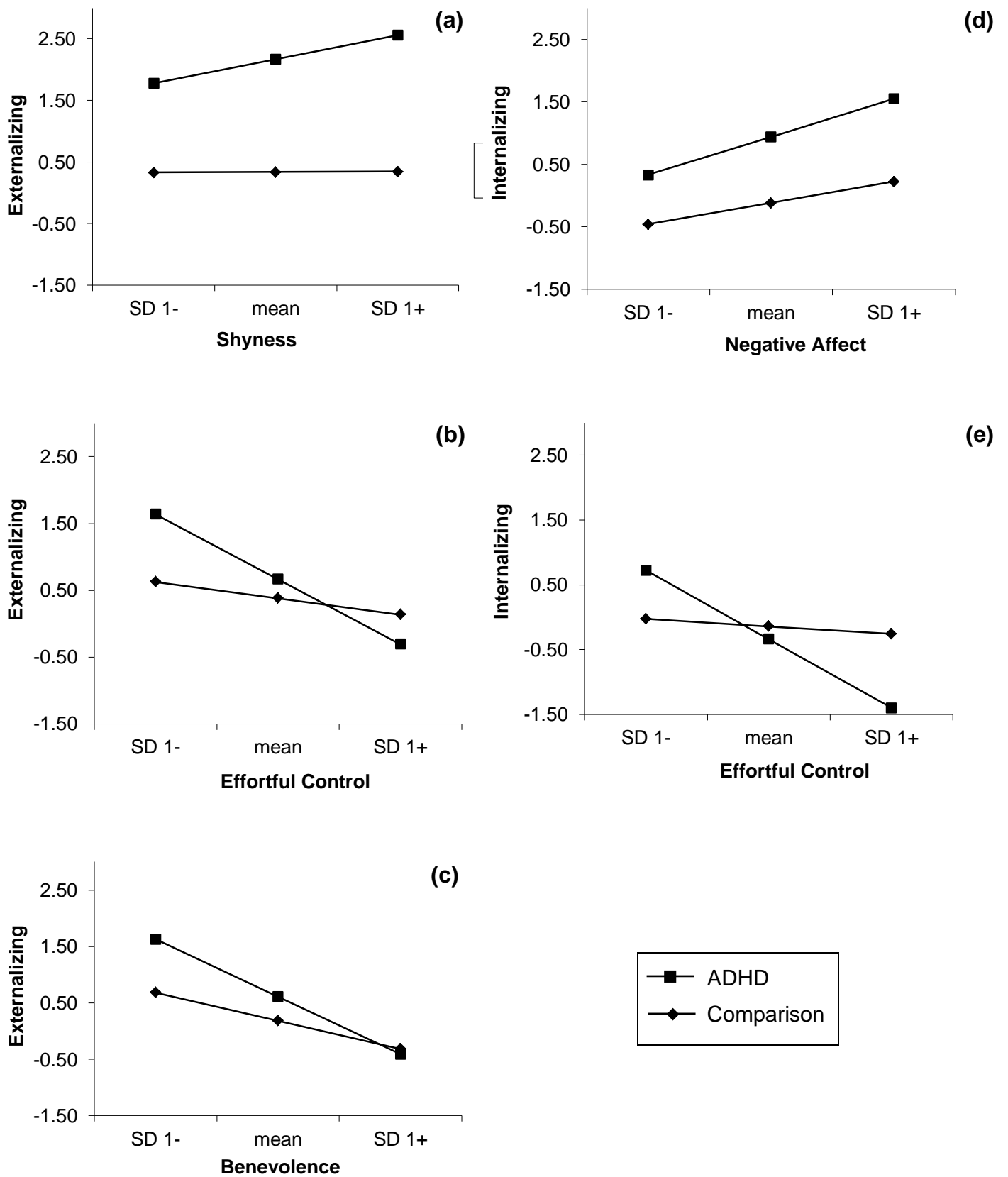
Temperament	Internalizing			Externalizing			Personality	Internalizing			Externalizing		
	ΔF	B	ΔR²	ΔF	B	ΔR²		ΔF	B	ΔR²	ΔF	B	ΔR²
Sex,-Age	1.24	.04, .01	.01	4.76*	-.07, -.03	.02	Sex, Age	1.24	.07, -.02	.01	4.76*	-.01, -.06**	.02
Group,-EMO	139.7**	1.11**, .39**	.35	219.0**	1.50**, .36**	.45	Group, EMS	199.8**	1.00**, -.49**	.44	149.2**	1.73**, -.16**	.36
Group-x-EMO	5.55		.01	4.17		.00	Group x EMS	4.50		.01	.00		.00
Sex,-Age	1.24	.12, -.03	.01	4.76*	-.01, -.04*	.02	Sex, Age	1.24	.17, -.04*	.01	4.76*	-.00, -.05**	.02
Group,-ACT	77.74**	1.65**, -.10	.23	151.0**	1.74**, .17**	.36	Group, EXT	110.7**	1.48**, -.29**	.23	135.1**	1.91**, .01	.34
Group-x-ACT	.33		.00	.02		.00	Group x EXT	.00		.00	1.45		.00
Sex,-Age	1.24	.16, -.01	.01	4.76*	.01, -.05**	.02	Sex, Age	1.24	.11, .-02	.01	4.76*	-.00, -.06	.02
Group,-SHY	126.19**	1.47**, .33**	.26	137.44**	1.83**, .01	.34	Group, IMA	77.02**	1.48**, -.09	.16	135.49**	1.89**, -.03	.34
Group-x-SHY	5.87		.00	15.43**	.38**	.02	Group x IMA	.12		.00	.15		.00
Sex,-Age	1.24	.05, -.01	.01	4.76*	-.06, -.05**	.02	Sex, Age	1.24	.10, -.01	.01	4.76*	-.04, -.02	.02
Group,-NA	144.89**	1.06**, .34**	.36	178.49**	1.69**, .26**	.40	Group, BEN	87.89**	1.23**, -.20**	.21	371.20**	.43*, -.50**	.58
Group-x-NA	7.12*	.27*	.01	.00		.01	Group x BEN	3.79		.01	30.67**	-.52**	.02
Sex,-Age	1.24	.13, -.01	.01	4.76*	.02, -.05**	.02	Sex, Age	1.24	.12, -.02	.01	4.76*	.00, -.06	.02
Group,-EC	81.21**	-.20, -.12	.19	170.53**	.29, -.25**	.39	Group, CON	74.65**	1.16**, -.04	.22	157.11**	1.56**, -.21**	.37
Group-x-EC	18.73**	-.95*	.01	14.05**	-.73**	.02	Group x CON	1.41		.00	2.20		.00
Sex,-Age	1.24	.01, -.01	.01	4.76*	.00, -.06**	.02							

Note. * $p \leq .01$, ** $p \leq .001$. ACT: Activity; BEN, Benevolence; CON, Conscientiousness; EC: Effortful control; EMO: Emotionality; EMS, Emotional Stability; EXT, Extraversion; IMA, Imagination; NA: Negative Affect; SU, Surgency.

Group,-SU	104.36**	1.59**, -.26**	.29	137.11**	1.89**, .06	.34
Group-x-SU	.08		.00	5.28		.01

Note. * $p \le .01$, ** $p \le .001$. ACT: Activity; BEN, Benevolence; CON, Conscientiousness; EC: Effortful control; EMO: Emotionality; EMS, Emotional Stability; EXT, Extraversion; IMA, Imagination; NA: Negative Affect; SU, Surgency.

Figure 1. Trait-by-group interactions predicting internalizing and externalizing problems.

Panel A. Interactions predicting externalizing problems.   Panel B. Interactions predicting internalizing problems.