Journal of Attention Disorders
17(3) 249–260

DOI: 10.1177/1087054711428741
jad.sagepub.com
SAGE

Differentiating Co-Occurring Behavior Problems in Children With ADHD: Patterns of Emotional Reactivity and Executive Functioning

Paulo A. Graziano[1], Joseph P. McNamara[2], Gary R. Geffken[2], and Adam M. Reid[2]

Abstract

Objective: This study examined whether "top-down" and "bottom-up" control processes can differentiate children with ADHD who exhibit co-occurring aggression and/or internalizing symptoms. **Method:** Participants included 74 children (*M* age = 10.7 years) with a *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*) diagnosis of ADHD. The authors' top-down measure was executive functioning (EF) indexed via two neuropsychological tasks whereas their bottom-up measure was emotional reactivity. Parents also reported on children's aggression and internalizing symptoms. **Results:** Emotional reactivity was associated with co-occurring aggressive symptoms, regardless of the presence of internalizing symptoms or ADHD symptom severity, whereas EF deficits were less likely to occur in children with ADHD and co-occurring internalizing symptoms. **Conclusion:** The authors' findings highlight the importance of integrating top-down and bottom-up regulatory measures when studying the multipathway conception of ADHD and its co-occurring problems. *(J. of Att. Dis. 2013; 17(3) 249-260)*

Keywords

ADHD, temperament, emotional reactivity, child, executive functioning, co-occurrence

The core symptoms of ADHD, consisting of inattention, hyperactivity, and impulsivity, are associated with significant impairment across children's social, cognitive, academic, behavioral, and familial functioning (Mash & Barkley, 2003). The public health costs associated with ADHD are also significant, as a recent illness analysis suggested an annual societal cost of US$42.5 billion (Pelham, Foster, & Robb, 2007). Given its prevalence and impact, it is not surprising that over the past three decades a considerable amount of research has focused on the etiology of ADHD (Barkley, 1997; Nigg, Goldsmith, & Sachek, 2004) and subsequent treatment (The MTA Cooperative Group, 1999; Pelham & Fabiano, 2008). In terms of the etiology of ADHD, the past two decades have seen a resurgence of cognitive theories that along with neuropsychological data have stressed the role of executive functioning (EF) processes or cognitive control (Barkley, 1997; Posner, 2004). More recently, however, researchers have emphasized the nonunitary nature of ADHD as a significant number of children with ADHD do not display EF deficits (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005; Willcutt et al., 2005). Subsequently, a temperament based multipathway conception of ADHD has been recently suggested to examine potentially distinct etiological determinants of symptoms of ADHD (i.e., inattention vs. hyperactivity/impulsivity) as well as its comorbidity with other disruptive behavior disorders such as oppositional defiant disorder (Martel, 2009; Martel, Nigg, & von Eye, 2009; Nigg, 2006).

ADHD and Temperament

Although theorists differ in the proposed numbers of temperament dimensions and their emphasis (i.e., behavior vs. emotion), they do agree that temperamental differences reflect biological or physiological differences (Calkins, 1997; Goldsmith, Lemery, Aksan, & Buss, 2000; Kagan,

[1]Florida International University, Miami, USA
[2]University of Florida, Gainesville, USA

Corresponding Author:
Paulo A. Graziano, Center for Children and Families & Department of Psychology, Florida International University, 11200 SW 8th Street, HLS 1 Rm. 235A, Miami, FL 33199, USA.
Email: pgrazian@fiu.edu

Reznick, & Snidman, 1987; M. Rothbart & Bates, 2006). The two most widely studied temperament dimensions include emotional reactivity and regulation (M. Rothbart & Bates, 2006). Emotional reactivity is characterized by a latency to respond and a threshold of responsiveness and can be measured behaviorally and biologically via cortisol, heart rate, vagal tone, and electroencephalography (Calkins, 1997; Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Gunnar, Tout, De Haan, Pierce, & Stansbury, 1996). It can also be referred to as negative emotionality or a tendency to respond intensely to emotion-evoking stimuli (Eisenberg et al., 1996). In terms of regulation and building on the work of Derryberry and Rothbart (1997), Eisenberg and Morris (2002) differentiated control processes that are voluntary from those that are more reactive. The voluntary branch refers to effortful control or an individual's ability to inhibit a dominant response and/or activate a subdominant response by voluntarily modifying one's own attention and behavior (Eisenberg & Morris, 2002; M. Rothbart & Bates, 2006). Reactive control, on the other hand, refers to aspects of control that appear to be automatic and/or involuntary (Eisenberg et al., 2009). As it relates to ADHD, this dimension has been referred to as *reactive under control* as it is thought to describe impulsive approach behaviors (Eisenberg et al., 2004).

Research within the developmental literature has clearly shown the importance of both effortful and reactive control processes as it relates to children's social competence and externalizing symptomology (Eisenberg et al., 1996, 2004, 2009; Eisenberg & Morris, 2002; Graziano, Keane, & Calkins, 2010). Similarly, previous studies that have used clinical samples show that children with ADHD perform or are reported as having poorer ER skills and are more reactive compared with controls (Maedgen & Carlson, 2000; Melnick & Hinshaw, 2000; Walcott & Landau, 2004). However, as pointed out by several researchers, there remains a significant gap in our knowledge of whether (a) these temperament dimensions relate to different ADHD symptoms and (b) whether such deficits are specific to ADHD symptoms or co-occurring difficulties such as aggression/oppositionality and/or internalizing symptoms (Foley, McClowry, & Castellanos, 2008; Martel, 2009; Martel et al., 2009).

Inattentive symptoms have been posited as being more closely related to deficits in effortful control due to a closer association with the meso-cortical dopamine system whereas symptoms of hyperactivity and impulsivity are posited as being related to deficits in reactive control due to a closer association with the meso-limbic dopamine system (Nigg, 2006; Sonuga-Barke, 2005). Attempting to integrate other temperament traits (e.g., negative emotionality or emotional reactivity) as well as neuropsychological models focusing on EF deficits, Martel and colleagues (2009) made a distinction of "top-down" and "bottom-up" processes that are related to ADHD. Top-down processes refer to more effortful aspects of regulation that are thought to rely heavily on prefrontal circuitry (Nigg & Casey, 2005). Temperamental traits of effortful control and conscientiousness as well as neuropsychological performance on EF tasks are considered top-down processes (Eisenberg & Morris, 2002; Martel & Nigg, 2006; M. K. Rothbart & Posner, 2006). Bottom-up processes relate to reactive behaviors that do not require conscious mental resources, are more influenced by emotional stimuli, and are thought to be mediated by subcortical brain regions such as the limbic system (Eisenberg et al., 1996). Temperamental traits of emotional reactivity, negative emotionality, neuroticism, agreeableness, and extraversion are considered bottom-up processes (Martel & Nigg, 2006). Indeed, a recent study by Martel and colleagues using structure equation modeling found preliminary support for using this two-factor approach in examining ADHD symptoms as the top-down factor was more closely associated with inattention symptoms of ADHD whereas the bottom-up factor was more closely associated with hyperactivity/impulsivity.

ADHD and Co-Occurring Aggression and Internalizing Symptoms

The significant co-occurrence of ADHD and aggressive or oppositional symptoms is well documented with estimates rates ranging from 30% to 50% (Biederman, 2005; Spencer, 2006). There is some evidence that children with ADHD with high levels of aggression tend to have poorer ER skills compared with children with ADHD with low levels of aggression (Melnick & Hinshaw, 2000). Unfortunately, most studies that have examined regulation and reactivity measures in children with ADHD were not able to examine co-occurring levels of aggression (Maedgen & Carlson, 2000; Walcott & Landau, 2004). Other temperamental traits such as negative emotionality have also been shown to be associated with more oppositional/defiance symptoms rather than pure ADHD symptoms (Martel & Nigg, 2006). However, it remains unclear within a clinical sample whether top-down and bottom-up processes can significantly differentiate which children with ADHD significantly display co-occurring aggression/oppositional symptoms.

While most of the research attention has been given to the co-occurrence between ADHD symptoms and aggression/oppositionality, approximately 25% of children with ADHD do exhibit an internalizing disorder (Jarrett & Ollendick, 2008). Evidence from the neuropsychological literature suggests that anxiety in children with ADHD may minimize the effects of impulsivity but at the same time make working memory deficits worse (see Schatz & Rostain, 2006, for a review). However, as pointed out by Jarrett and Ollendick (2008) in their own review of the literature, most studies examining the neuropsychological or

top-down processes involved in children with ADHD's internalizing symptoms have failed to account for co-occurring externalizing symptoms and have not included emotional reactivity or bottom-up processes. Temperament researchers have suggested an interaction between top-down and bottom-up processes in the development of anxiety in children with ADHD. For example, Nigg and colleagues (2004) proposed that early difficulties with top-down processes (e.g., effortful control) along with the combined temperament traits of high emotional negativity and low hostility place children in a pathway for the development of both ADHD and anxiety difficulties. However, most empirical studies have taken place in normative samples showing that, indeed, low effortful control along with a reactive overcontrolling or behaviorally inhibited style of approaching novel or stressful situations relates to internalizing symptoms (Eisenberg et al., 2001, 2009; Eisenberg & Morris, 2002; Kagan, 1999). High emotional reactivity/negativity and lower levels of ER skills have also been shown in children and adolescents suffering from anxiety (Carthy, Horesh, Apter, & Gross, 2010), although co-occurring ADHD symptoms were not assessed.

In summary, recent research has alluded to the importance of examining top-down or more effortful control processes versus bottom-up or more reactive processes to better understand the multifaceted nature of ADHD, its symptoms, and its co-occurrence with aggression/oppositionality and internalizing symptoms (Martel et al., 2009). Research has shown that children with ADHD generally have deficits in either top-down and/or bottom-up processes compared with children without ADHD (Friedman-Hill et al., 2010; Sergeant, Geurts, Huijbregts, Scheres, & Oosterlaan, 2003). It has also been recently shown that the deficits seen in top-down processes are more closely related to the inattentive symptoms of ADHD whereas the bottom-up processes are more closely related to the hyperactivity/impulsivity symptoms of ADHD (Martel et al., 2009; Martel & Nigg, 2006). However, what remains unclear is the extent to which these deficits are specific to ADHD symptoms or if they are more closely related to co-occurring difficulties such as aggression/oppositionality and/or internalizing symptoms. Understanding the mechanisms by which ADHD symptoms contribute to co-occurring difficulties is crucial as it may allow treatments to better target such differentiating factors. This is particularly important given work from the MTA cooperative group (1999) showing a differential response to traditional treatments of ADHD (e.g., medication only vs. combined treatment) based on comorbidity status (Jensen et al., 2001).

Current Study

The purpose of this study was to examine within a clinical sample whether top-down and bottom-up regulatory processes can significantly differentiate children with ADHD who exhibit co-occurring aggression and/or internalizing symptoms using dimensional and categorical approaches. Within the dimensional approach, we sought to examine concurrent associations between top-down and bottom-up regulatory processes and children with ADHD's co-occurring aggression and internalizing symptoms. Based on previous research, we expected higher levels of emotional reactivity (i.e., our bottom-up regulatory process) to be positively associated with co-occurring aggression and internalizing symptoms whereas higher levels of EF (i.e., our top-down regulatory process) to be negatively associated with aggressive and internalizing symptoms. A categorical approach was also conducted to compare children with ADHD who display clinically significant levels of aggression and internalizing symptoms compared with those who exhibit only one co-occurring problem. We also expected emotional reactivity levels to be higher in children with ADHD who displayed co-occurring aggression and internalizing symptoms. In terms of EF, we expected children with ADHD displaying co-occurring internalizing symptoms to have higher EF compared with children with pure ADHD and children with ADHD with co-occurring aggression or co-occurring aggression and internalizing symptoms.

Method

Participants

Participants for this study included 74 children (16 girls) with a diagnosis of ADHD whose parents provided consent to participate in the study at a large university hospital in the southeastern United States. The mean age of the participating children was 10.7 years (range = 6-17 years of age). These children were primarily referred from psychiatrists (69%) and pediatricians (14%), and some were self-referred (11%). All participants had a previous *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association [APA], 1994) diagnosis of ADHD ($n = 47$ for combined type, $n = 24$ for predominantly inattentive type, $n = 1$ for predominantly hyperactive/impulsive type, and $n = 2$ for ADHD not otherwise specified) confirmed by a licensed psychologist via a comprehensive clinical diagnostic assessment including the use of a semistructure interview (e.g., diagnostic interview schedule for children) and Conners' Parenting Rating Scales. In terms of treatment history, 64% of the children in our sample were currently taking medications to address their symptoms. Exclusionary criteria included a diagnosis of mental retardation, autistic disorder, or a psychotic disorder. The sample was primarily Caucasian (72%) with an additional 15% of children being classified as African American, 10% as Hispanic, and 3% as biracial. In all, 45% of children were from an intact biological family, 27% were from a single biological parent household, 11% were from

a remarried household, and 8% were in an adoptive/foster family placement. The median family income was between US$50,000 and US$65,000 per year (range = US$20,000 to >US$200,000).

Measures

ADHD symptoms. To assess children's current severity level of ADHD symptoms, the Conners' Parent Rating Scale–3rd Edition (Conners-3) was administered (Conners, 2008). The Conners-3 is a widely used questionnaire that covers core symptoms of ADHD as well as comorbid problems such as oppositional defiant disorder symptoms. The parent version used for children ages 6 to 18 contains 108 items. Each item on the Conners-3 is rated on a 4-point scale with respect to the frequency of occurrence (*never, occasionally, often*, and *very often*). The measure yields *T*-scores on internalizing, hyperactivity/impulsivity, learning problems, EF, defiance/aggression, and peer relations as well as on *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; APA, 2000) symptom scales. The Conners-3 has well-established internal consistency, reliability, and validity (Conners, 2008). For the purpose of the present study, the *inattention* and *hyperactivity/impulsivity T*-scores were used as indicators of ADHD symptom severity.

Medication status. Children's medication status was assessed during the clinical interview as part of the diagnostic assessment. Parents also completed a demographic questionnaire, in which they listed their child's current medications. A medical records review was conducted when parents were not sure which medications their children were taking. Based on this information, we created three medication status groups. The first group, labeled *medication naïve*, included children who had never received any type of psychotropic medication (n = 26). The second group, labeled *stimulant* group, included children who were currently taking a stimulant medication, such as Concerta (n = 31). The third group, labeled *nonstimulant*, consisted of children who were currently taking a psychotropic medication that was not a stimulant, such as atomoxetine (n = 17).

Behavioral/emotional functioning. To assess children's behavioral functioning, parents completed the Behavior Assessment System for Children–2nd Edition (BASC-2; Reynolds & Kamphaus, 2004). The BASC-2 is a widely used behavior checklist that taps emotional and behavioral domains of children's functioning. There are three parent versions: Preschool Form (ages 2-5, 134 total items), Child Form (ages 6-11, 160 total items), and Adolescent Form (ages 12-21, 150 total items). Each item on the BASC-2 is rated on a 4-point scale with respect to the frequency of occurrence (*never, sometimes, often*, and *almost always*). The measure yields scores on broad internalizing, externalizing, and behavior symptom domains as well as on specific adaptive/social functioning skills scales. The BASC-2 has well-established internal consistency, reliability, and validity (Reynolds & Kamphaus, 2004). Given the wide age range of our sample and different forms used, the aggression and internalizing subscale *T*-scores were used rather than raw scores.

Bottom-up regulatory measure: Emotional reactivity. To assess children's bottom-up control processes, parents completed the ER Checklist (Shields & Cicchetti, 1997). The ER Checklist is a 23-item questionnaire that uses a 4-point Likert-type scale (1 = *almost always* to 4 = *never*) and yields two subscales: the Negativity/Lability scale (15 items), which represents negative affect/mood lability, and the Emotion Regulation scale (8 items), which assesses processes central to adaptive regulation. The Negativity/Lability scale (Cronbach's α = .79) was the focus of the current study as our measure of children's emotional reactivity.

Top-down regulatory measure: EF. Children were administered the Trail Making Test and Color-Word Interference Test from the Delis–Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001). These two subtests are widely used neuropsychological tests that are regarded as measuring EF. The Trail Making Test consists of five conditions: visual scanning, number sequencing, letter sequencing, number–letter switching, and motor speed. Of interest to the current study is the *number–letter switching* condition. The number–letter switching condition is the primary EF condition as it requires cognitive flexibility to successfully switch back and forth between connecting numbers and letters in sequence. The Color-Word Interference Test is a stroop task that involves four conditions: color naming, word reading, inhibition, and inhibition/switching. Of interest to the current study is the *inhibition/switching* condition, which is the primary EF condition in this test. On this task, children are presented with a stimulus page displaying color names that are written in an incongruent ink color. Half of the words also appear in a box. Children are then instructed to name the ink color as quickly as possible while inhibiting the more automatic word reading response. However, if the word appears in a box, children have to switch the application of the rules and read the word. Performances on both tasks were assessed by the *total time in seconds* it took children to complete it with faster scores being indicative of better EF skills. *Standard scores* were also derived for children 8 years and older (no norms are available for younger children). Given the strong correlation between children's performance on the number–letter switching and inhibition/switching tasks (r = .71, $p < .001$), a single measure of EF was created by standardizing the total time in seconds of both tasks, averaging them together, and then restandardizing the score. This composite was also reverse scored to facilitate interpretation with higher scores indicative of better EF.

Table 1. Descriptive Statistics for All Variables.

	M	*SD*	Minimum	Maximum	*n*
ADHD symptoms severity (CPRS-3)					
Inattention *T*-score (P)	78.78	10.54	52	100	73
Hyperactivity/impulsivity *T*-score (P)	76.75	16.90	43	113	73
EF (D-KEFS)					
Color-word subtest: Condition 4					
Inhibition-switching total time (L)	103.90	37.56	47	180	68
Inhibition-switching standard score (L)	7.95	3.11	1	14	55
Trail making: Condition 4					
Number–letter switching total time (L)	153.91	66.03	38	240	70
Number–letter switching standard score (L)	6.89	3.43	1	14	55
Emotional Reactivity (ER Checklist)					
Emotional Negativity/Lability subscale (P)	2.32	.55	1.33	3.53	72
BASC-2					
Aggression *T*-score (P)	56.16	12.65	37	101	74
Internalizing composite *T*-score (P)	58.56	14.85	33	92	73

Note: CPRS-3 = Conners' Parent Rating Scale–3rd Edition; (P) = parent report; EF = executive functioning; D-KEFS = Delis–Kaplan Executive Function System; (L) = laboratory measure; ER = emotion regulation; BASC-2 = Behavior Assessment System for Children–2nd Edition.

Data Analytic Strategy

Descriptive statistics for the study variables, which were all normally distributed, are presented in Table 1. All analyses were conducted using SPSS 18.0. All available data were used for each analysis. First, preliminary analyses were conducted to determine any associations between demographic characteristics (i.e., sex, race, maternal income, maternal education, medication status, child age) and any of the study's variables. Second, dimensional analyses, conducted via regressions, were used to examine the link between bottom-up and top-down regulatory processes and children with ADHD's co-occurring aggression and internalizing symptoms. Third, categorical analyses were conducted to examine whether EF and/or emotional negativity differentiate children with ADHD who display clinically significant levels of aggression, internalizing symptoms, or both. For all analyses involving our a priori hypotheses, alpha was set at .05 whereas statistical trends were recognized at .10. We also applied Bonferroni's correction on all contrast tests to reduce Type I error.

Results

Preliminary analyses indicated that children's age was significantly related to parent report of internalizing symptoms, $r = .29$, $p = .01$, indicating that older children were more likely to have been rated by their parents as displaying internalizing symptoms. Age was also significantly related to EF as measured by the D-KEFS, $r = .82$, $p < .001$, indicating, not surprisingly, that as children got older, they performed better on the EF tasks. No other demographic characteristics were related to any of the study variables. Due to these findings, children's age was controlled in subsequent analyses. Last, preliminary analyses indicated that children among the different medication status groups did not differ on any demographic variables, severity of ADHD symptoms, EF performance, or emotional reactivity.

Associations Among Variables

Partial correlations, controlling for children's age, are presented in Table 2. Both ADHD symptom clusters (inattention and hyperactivity/impulsivity) were significantly associated with emotional reactivity, EF, comorbid aggression, and comorbid internalizing symptoms. Thus, children with ADHD with higher severity levels of inattention and hyperactivity/impulsivity symptoms performed worse on EF tasks and were reported by parents as having greater levels of emotional lability, aggression, and internalizing symptoms. Emotional reactivity was also significantly associated with EF, aggression, and internalizing symptoms such that children with ADHD who were reported as having greater levels of emotional lability performed worse on EF tasks and were also reported to have higher levels of aggression and internalizing symptoms. EF was found to be significantly associated with aggression but not internalizing symptoms. This indicates that children who performed worse on the EF tasks were more likely to be reported as having higher levels of aggression but not internalizing symptoms. Last, aggression and internalizing symptoms were positively associated with each other.

Table 2. Correlations Among Variables.

Variable	1	2	3	4	5	6
ADHD–inattention *T*-score	—					
ADHD–hyper/impulsivity *T*-score	.70*** (<.001)	—				
EF *z* score	–.27* (.029)	–.24* (.050)	—			
Emotional reactivity	.57*** (<.001)	.63*** (<.001)	–.30* (.013)	—		
Aggression *T*-score	.42*** (<.001)	.37** (.002)	–.42*** (<.001)	.73*** (<.001)	—	
Internalizing *T*-score	.41*** (.001)	.43*** (<.001)	.12 (.340)	.46*** (<.001)	.26* (.034)	—

Note: EF = executive functioning. Values enclosed in parentheses represent *p* values. All correlations controlled for age.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Regression Analyses Examining Predictors of Co-Occurring Problems.

	β	β *p* value	R^2	R^2 change	*F* change	*F* change *p* value
Aggression symptoms *T*-score						
Step 1			.20	.20	3.89**	.007
Age	.19	.212				
ADHD-inattention *T*-score	.08	.496				
ADHD-hyperactivity/impulsivity *T*-score	−.15	.114				
Internalizing symptoms *T*-score	−.02	.953				
Step 2			.60	.40	29.56***	.000
Emotional reactivity	.75***	.000				
EF *z* score	−.37*	.023				
Internalizing symptoms *T*-score						
Step 1			.26	.26	5.54**	.001
Age	−.22	.251				
ADHD-inattention *T*-score	.19	.207				
ADHD-hyperactivity/impulsivity *T*-score	.14	.392				
Aggression symptoms *T*-score	−.01	.953				
Step 2			.39	.13	5.99**	.004
Emotional reactivity	.35*	.050				
EF *z* score	.51**	.009				

Note: EF = executive functioning.
*$p < .05$. **$p < .01$. ***$p < .001$.

Dimensional Analyses

Regression analyses were conducted to examine the concurrent associations between bottom-up and top-down regulatory processes (i.e., emotional reactivity and EF) and children with ADHD's co-occurring aggression and internalizing symptoms. To control for ADHD symptom severity, the inattention and hyperactivity/impulsivity *T*-scores were entered simultaneously in the first step along with children's age. Given the association between aggression and internalizing symptoms, each served as a control variable (e.g., when aggression was the dependent variable, internalizing symptoms were controlled for in the first step and vice versa.). As seen in Table 3, emotional reactivity and EF skills were associated with co-occurring aggression (Cohen's $d = 1.67$ and 0.60, respectively), even after controlling for severity of ADHD symptoms, age, and co-occurring internalizing symptoms (Cohen's $d = 0.52$ and 0.69, respectively). Thus, children with ADHD who exhibited higher levels of emotional reactivity, as reported by parents, were reported as having higher levels of aggression, whereas children with ADHD who exhibited higher EF skills were reported as having lower levels of co-occurring aggression. A similar finding occurred in regard to the link between emotional reactivity and internalizing symptoms, in which children with ADHD who exhibited higher levels of emotional reactivity were reported as having higher levels of internalizing symptoms. However, children with ADHD who exhibited higher EF skills were more likely to have co-occurring internalizing symptoms

Categorical Analyses: Creation of Behavior Problem Profiles

Categorical analyses were necessary to further determine whether EF and/or emotional negativity differentiate children with ADHD who display clinically significant levels of aggression, internalizing symptoms, or both. Hence, the aggression subscale and internalizing composite from the BASC-2 completed by parents were used to generate groups of children with ADHD who displayed different behavior problem profiles. Children were selected for the "pure ADHD" group if their *T*-scores on the aggression and internalizing composite scales were below 60 (n = 32), which is considered the borderline clinical cutoff (Reynolds & Kamphaus, 2004). Children were selected for the "ADHD with co-occurring aggression (ADHD-CA)" group if their aggression *T*-score was at or above 60 and their internalizing *T*-score was below 60 (n = 14). Children were selected for the "ADHD with co-occurring internalizing (ADHD-CI)" group if their internalizing *T*-score was at or above 60 and their aggression *T*-score was below 60 (n = 17). Last, children were selected for the "ADHD with co-occurring aggression and internalizing (ADHD-CAI)" group if their *T*-scores on both the aggression and internalizing scales were at or above 60 (n = 11).

Descriptive statistics for these comorbidity groups appear in Table 4. There were no significant differences between the groups in terms of children's race, gender, or family income. However, there was a significant difference between the groups in terms of children's age, $F(3, 70) = 2.89$, $p = .041$, with children in the ADHD-CI group being older than children in the pure ADHD group ($p = .032$). No other age differences between groups were found. Chi-square analyses also indicated no significant differences in terms of children's medication status and comorbidity group membership, ($\chi^2 = 8.71$, $p = .19$).

Categorical Analyses: ADHD Symptom Severity

A MANCOVA was conducted to determine whether severity of ADHD symptoms (inattention and hyperactivity/impulsivity) significantly differed across comorbid groups while controlling for children's age. The MANCOVA was significant, $F(6, 134) = 3.80$, $p = .002$, Cohen's $d = 0.84$, observed power = 0.96, with follow-up ANCOVAs also significant for both inattention, $F(3, 68) = 6.09$, $p = .001$, Cohen's $d = 1.03$, observed power = 0.95, and hyperactivity/impulsivity symptoms, $F(3, 68) = 7.28$, $p < .001$, Cohen's $d = 1.12$, observed power = 0.98. As seen in Table 5, follow-up contrast tests, using Bonferroni's correction to control the Type I error rate, revealed that the children in the pure ADHD group were rated by their mothers as having less severe symptoms of inattention and hyperactivity/impulsivity compared with children in the ADHD-CI and ADHD-CAI groups but had similar symptoms severity compared with children with ADHD-CA. No significant differences were found in ADHD symptoms severity among children in the ADHD-CI, ADHD-CA, or ADHD-CAI groups.

Categorical Analyses: Top-Down and Bottom-Up Regulatory Processes

A MANCOVA was conducted to determine whether EF skills and emotional reactivity significantly differentiate comorbid groups while controlling for children's age and ADHD symptom severity (inattention and hyperactivity/impulsivity). The MANCOVA was significant, $F(6, 118) = 8.38$, $p < .001$, Cohen's $d = 1.31$, with follow-up ANCOVAs also significant for both EF, $F(3, 60) = 4.58$, $p = .006$, Cohen's $d = 0.97$, observed power = 0.87, and emotional reactivity, $F(3, 60) = 13.54$, $p < .001$, Cohen's $d = 1.63$, observed power = 1.00. As seen in Table 5, follow-up contrast tests, using Bonferroni's correction to control the Type I error rate, revealed that children in the pure ADHD and the ADHD-CI groups were reported by parents as displaying significantly less emotional reactivity compared with children in the ADHD-CA and ADHD-CAI groups. No significant differences in emotional reactivity were found between children in the pure ADHD and ADHD-CI groups or between children in the ADHD-CA and ADHD-CAI groups. In terms of EF, children in the ADHD-CI group obtained significantly better standardized scores compared with children in the pure ADHD and ADHD-CA groups, and marginally better than children in the ADHD-CAI group. No significant differences in EF performance were found between children in the pure ADHD, ADHD-CA, and ADHD-CAI groups.

Discussion

The purpose of this study was to examine whether top-down and bottom-up processes can significantly differentiate children with ADHD who exhibit co-occurring aggression and/or internalizing symptoms using both dimensional and categorical approaches. First, it is important to point out that our top-down and bottom-up processes were moderately associated with each other such that children with ADHD who were reported as having greater levels of emotional reactivity performed worse on EF tasks. This association is consistent with previous developmental research noting an important association between children's ability to regulate their emotions and higher order cognitive functions (Blair, Granger, & Peters Razza 2005; Ochsner & Gross, 2005). Our study extends the literature by indicating that the association between emotional reactivity and EF difficulties may be even more prominent in a clinical population of children with ADHD who may

Table 4. Profile of Comorbidity Groups.

	Pure ADHD	ADHD-CA	ADHD-CI	ADHD-CAI
	(*n* = 32)	(*n* = 14)	(*n* = 17)	(*n* = 11)
Age in months	97 (40)[a]	120 (33)[ab]	142 (43)[b]	142 (52)[ab]
Gender				
Male	25	13	12	8
Female	7	1	5	3
Race				
Caucasian	23	10	11	9
African American	5	2	2	2
Hispanic	3	1	3	0
Biracial	1	1	1	0
Medication status				
Medication naïve	14	6	3	3
Stimulant	15	4	7	5
Nonstimulant	3	4	7	3
Aggression subscale *t* test	47.58 (1.28)[a]	68.80 (1.91)[b]	50.99 (1.80)[a]	73.02 (2.15)[b]
Internalizing composite *t* test	47.72 (1.40)[a]	51.46 (2.09)[a]	74.81 (1.97)[b]	73.23 (2.35)[b]

Note: ADHD-CA = ADHD with co-occurring aggression; ADHD-CI = ADHD with co-occurring internalizing; ADHD-CAI = ADHD with co-occurring aggression and internalizing. Values enclosed in parentheses represent standard deviations. Means in the same row that do not share superscripts differ at $p < .05$.

Table 5. Summary of Results Comparing Comorbidity Groups.

	Pure ADHD[a]	ADHD-CA[b]	ADHD-CI[c]	ADHD-CAI[d]	*p* value
ADHD symptom severity–inattention *T*-score	73.94 (1.71)	80.16 (2.55)	81.41 (2.41)	87.87 (3.01)	0.275[ab], 0.090[ac], 0.001[ad], 1.00[bc], 0.329[bd], 0.586[cd]
ADHD symptom severity–hyperactivity/impulsivity *T*-score	68.24 (2.72)	79.18 (4.05)	81.70 (3.82)	92.19 (4.78)	0.165[ab], 0.040[ac], 0.000[ad], 1.00[bc], 0.251[bd], 0.543[cd]
EF *z* score	–0.07 (0.11)	–0.17 (0.14)	0.48 (0.14)	–0.06 (0.18)	1.00[ab], 0.025[ac], 1.00[ad], 0.009[bc], 1.00[bd], 0.090[cd]
EF Standard scores+	7.01 (0.62)	6.07 (0.85)	9.04 (0.69)	7.45 (0.94)	—
Emotional reactivity	2.02 (0.07)	2.62 (0.09)	2.3 (0.09)	2.9 (0.12)	0.000[ab], 0.350[ac], 0.000[ad], 0.058[bc], 0.887[bd], 0.001[cd]

Note. ADHD-CA = ADHD with co-occurring aggression; ADHD-CI = ADHD with co-occurring internalizing; ADHD-CAI = ADHD with co-occurring aggression and internalizing; EF = executive functioning. Values enclosed in parentheses represent standard errors. *p* values are reported for contrast tests between comorbidity groups (e.g., [ab] = comparison of pure ADHD and ADHD-CA groups, Cd = comparison of ADHD-CI and ADHD-CAI groups), + contrast tests for examining differences in executive functioning were conducted with *z* scores as standard scores are not available for children younger than 8 years and are only reported for descriptive purposes.

already be experiencing significant self-regulation difficulties across other domains such as behavioral inhibition and sustained attention.

Second, our dimensional analyses indicated that emotional reactivity is positively associated with co-occurring aggression and internalizing symptoms, regardless of the severity of ADHD symptoms. Categorical analyses confirmed these findings and indicated that children in the pure ADHD and ADHD-CI groups were reported by parents as displaying significantly less emotional reactivity compared with children in the ADHD-CA and ADHD-CAI groups. Previous research has documented that children with ADHD are reported as being more labile or emotionally reactive compared with their peers (Walcott & Landau, 2004). Studies have also documented that children with ADHD and comorbid aggression/oppositional defiant disorder symptoms have worse functional outcomes including peer problems than children with only ADHD (Gresham, MacMillan, Bocian, Ward, & Forness, 1998; Hinshaw & Melnick, 1995). Fewer studies, however, have examined comorbid internalizing and/or externalizing symptoms (Eisenberg et al., 2001). Our findings extend the literature and indicate via large effect sizes (Cohen's *d* range = 1.63-1.67) that higher levels of

emotional reactivity place children with ADHD at a higher risk of having concurrent aggressive symptoms, regardless of whether such problems are accompanied by internalizing symptoms.

Third, our dimensional analyses indicated via moderate effect sizes (d range = 0.60-0.69) that while children with ADHD who performed better on EF tasks were less likely to have co-occurring aggression, they were more likely to display co-occurring internalizing symptoms. Categorical analyses further specified that children in the ADHD-CI group obtained significantly better scores on the standardized EF tasks compared with children in the pure ADHD, ADHD-CA, and ADHD-CAI groups. Previous neuropsychological studies provided some evidence for internalizing symptoms mitigating impulsivity but at the same time make working memory deficits worse (see Schatz & Rostain, 2006, for a review). However, these studies had not specifically compared children with ADHD with different co-occurring behavior problems profiles—internalizing symptoms versus internalizing and aggressive symptoms (Jarrett & Ollendick, 2008). In addition, whereas current neuropsychological theories of ADHD point to executive dysfunction as the primary deficit (Barkley, 1997; Willcutt et al., 2005), recent studies demonstrate that not all children with ADHD show such deficits (Biederman et al., 2004; Loo et al., 2007; Nigg et al., 2005). Although we did not have a comparison control group, the mean standardized score achieved by children in the ADHD-CI group (M = 9.04, 37th percentile) places them in the average range of functioning compared with their same-age peers. In contrast, children in the pure ADHD group, ADHD-CAI, and ADHD-CA performed in the low average to borderline impaired range compared with their same-age peers. These findings suggest that children with ADHD and comorbid internalizing symptoms may have a more intact neuropsychological profile compared with other children with ADHD. It is also important to point out that research has shown that variations of methylphenidate can have a positive effect on children's EF (Bedard, Martinussen, Icokwicz, & Tannock, 2004; Bedard & Tannock, 2008; Hazel-Fernandez, Klorman, Wallace, & Cook, 2006). Although we did not find significant differences in EF performance (or severity of ADHD symptoms) among children in different medication statuses, it is possible that medication might have affected EF performance along with the other behavioral indicators we examined. The cross-sectional aspect of this study prevented us from determining the baseline functioning of children prior to the use of medication and whether any improvements were observed after medication initiation.

As it relates to the multipathway conception of ADHD and its co-occurring problems, it may be the case that a bottom-up process like emotional reactivity represents a more proximal risk factor for the development of co-occurring aggressive symptoms whereas other factors (e.g., impairment due to aggressive or ADHD symptoms) may lead a child to further develop internalizing problems. For example, research has shown that the association between internalizing symptoms and social dysfunction is mediated by earlier co-occurring externalizing symptoms (Bagwell, Molina, Kashdan, Hoza, & Pelham, 2006). In terms of top-down processes, our findings contribute to the literature by showing that EF deficits may not be a prominent aspect of children with ADHD with co-occurring internalizing problems, although more research is needed to clarify why this may be the case.

In terms of this study's limitations, it is important to point out that unlike our measure of EF, which was based on standardized neuropsychological tasks, we did not have an objective measure of children's emotional reactivity. Hence, because many of our significant findings were based on parent report (emotional reactivity, behavioral problems, and ADHD symptom severity), we must acknowledge the potential that our findings were related to source variance. While the use of different questionnaires for each domain of functioning reduces some of the source variance, the use of a laboratory measure of emotional reactivity (e.g., frustration task) as well as the inclusion of teacher reports would have strengthened the findings. The cross-sectional aspect of this study is another limitation in our ability to infer not only the temporal association between emotional reactivity, EF, and comorbid behavior problems but also its directionality. Future longitudinal studies will be better able to examine whether emotional reactivity and EF difficulties represent risk factors for the development of co-occurring behavioral problems in children with ADHD or if they are a consequence of such problems. Last, our moderate sample size and clinically based sample without a control comparison group may limit the generalization of our findings.

Despite these limitations, our study contributes to literature by showing the usefulness of integrating bottom-up and top-down regulatory-based measures when studying children with ADHD and their co-occurring behavioral problems. In terms of clinical implications, our findings indicate that evidence-based assessments and treatments for ADHD should pay closer attention to children's emotional reactivity rather than just symptom severity. Whereas some researchers have argued for the creation of an executive dysfunction subtype of ADHD (see Nigg et al., 2005, for a review), we would argue that differentiating children with ADHD who are also emotionally labile is equally as important. Research is emerging demonstrating how such emotional lability can also place children with ADHD at risk for greater functional impairment (Anastopoulos et al., 2011) as well as more serious issues such as substance use (Sobanski et al., 2010). Although work from the MTA group shows children with ADHD's differential treatment response according to their comorbidity status (Jensen et al., 2001), we do not know

whether such differential treatment response is due to underlying emotional reactivity and/or EF deficits. Finally, it will be important for future research to examine whether adjustments to ADHD treatments (e.g., including ER modules, coping with anger) are necessary for children with emotional lability problems.

Declaration of Conflicting Interests

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

Funding

The author(s) received no financial support for the research and/or authorship of this article.

References

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

Anastopoulos, A., Smith, T., Garrett, M., Morrissey-Kane, E., Schatz, N., Sommer, J., . . . Ashley-Koch, A. (2011). Self-regulation of emotion, functional impairment, and comorbidity among children with AD/HD. *Journal of Attention Disorders*, *15*, 583-592.

Bagwell, C., Molina, B., Kashdan, T., Hoza, B., & Pelham, W. (2006). Anxiety and mood disorders in adolescents with childhood attention-deficit/hyperactivity disorder. *Journal of Emotional and Behavioral Disorders*, *14*, 178-187.

Barkley, R. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, *121*, 65-94.

Bedard, A. C., Martinussen, R., Icokwicz, A., & Tannock, R. (2004). Methylphenidate improves visual-spatial memory in children with attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *43*, 260-268.

Bedard, A. C., & Tannock, R. (2008). Anxiety, methylphenidate response, and working memory in children with ADHD. *Journal of Attention Disorders*, *11*, 546-557.

Biederman, J. (2005). Attention-deficit/hyperactivity disorder: A selective overview. *Biological Psychiatry*, *57*, 1215-1220.

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., . . . Faraone, S. V. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of Consulting and Clinical Psychology*, *72*, 757-766.

Blair, C., Granger, D., & Peters Razza, R. (2005). Cortisol reactivity is positively related to executive functioning in preschool children attending head start. *Child Development*, *76*, 554-567.

Calkins, S. D. (1997). Cardiac vagal tone indices of temperamental reactivity and behavioral regulation in young children. *Developmental Psychobiology*, *31*, 125-135.

Carthy, T., Horesh, N., Apter, A., & Gross, J. J. (2010). Patterns of emotional reactivity and regulation in children with anxiety disorders. *Journal of Psychopathology and Behavioral Assessment*, *32*, 23-36.

Conners, C. K. (2008). *The Conners 3rd Edition (Conners 3)*. North Tonawanda, NJ: Multi-Health System.

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *D-KEFS executive function system: Examiners manual*. San Antonio, TX: Psychological Corporation.

Derryberry, D., & Rothbart, M. (1997). Reactive and effortful processes in the organization of temperament. *Development and Psychopathology*, *9*, 633-652.

Eisenberg, N., Cumberland, A., Spinrad, T. L., Fabes, R. A., Shepard, S. A., Reiser, . . . Guthrie, I. K. (2001). The relations of regulation and emotionality to children's externalizing and internalizing problem behavior. *Child Development*, *72*, 1112-1134.

Eisenberg, N., Fabes, R., Guthrie, I., Murphy, B., Maszk, P., Holmgren, R., & Suh, K. (1996). The relations of regulation and emotionality to problem behavior in elementary school children. *Development and Psychopathology*, *8*, 141-162.

Eisenberg, N., & Morris, A. (2002). Children's emotion-related regulation. *Advances in Child Development and Behavior*, *30*, 189-229.

Eisenberg, N., Spinrad, T., Fabes, R., Reiser, M., Cumberland, A., Shepard, S., . . . Thompson, M. (2004). The relations of effortful control and impulsivity to children's resiliency and adjustment. *Child Development*, *75*, 25-46.

Eisenberg, N., Valiente, C., Spinrad, T., Cumberland, A., Liew, J., Reiser, M., . . . Losoya, S. H. (2009). Longitudinal relations of children's effortful control, impulsivity, and negative emotionality to their externalizing, internalizing, and co-occurring behavior problems. *Developmental Psychology*, *45*, 988-1008.

Foley, M., McClowry, S. G., & Castellanos, F. X. (2008). The relationship between attention deficit hyperactivity disorder and child temperament. *Journal of Applied Developmental Psychology*, *29*, 157-169.

Fox, N., Henderson, H., Rubin, K., Calkins, S., & Schmidt, L. (2001). Continuity and discontinuity of behavioral inhibition and exuberance: Psychophysiological and behavioral influences across the first four years of life. *Child Development*, *72*, 1-21.

Friedman-Hill, S. R., Wagman, M. R., Gex, S. E., Pine, D. S., Leibenluft, E., & Ungerleider, L. G. (2010). What does distractibility in ADHD reveal about mechanisms for top-down attentional control? *Cognition*, *115*, 93-103.

Goldsmith, H. H., Lemery, K. S., Aksan, N., & Buss, K. A. (2000). Temperamental substrates of personality development. In D. Molfese & V. Molfese (Eds.), *Temperament and personality development across the lifespan* (pp. 1-32). Hillsdale, NJ: Erlbaum.

Graziano, P. A., Keane, S. P., & Calkins, S. D. (2010). Maternal behaviour and children's early emotion regulation skills differentially predict development of children's reactive control and later effortful control. *Infant and Child Development*, *19*, 333-353.

Gresham, F., MacMillan, D., Bocian, K., Ward, S., & Forness, S. (1998). Comorbidity of hyperactivity–impulsivity–inattention and conduct problems: Risk factors in social, affective, and academic domains. *Journal of Abnormal Child Psychology*, *26*, 393-406.

Gunnar, M., Tout, K., De Haan, M., Pierce, S., & Stansbury, K. (1996). Temperament, social competence, and adrenocortical activity in preschoolers. *Developmental Psychobiology*, *31*, 65-85.

Hazel-Fernandez, L., Klorman, R., Wallace, J., & Cook, S. (2006). Methylphenidate improves aspects of executive function in African American children with ADHD. *Journal of Attention Disorders*, *9*, 582-589.

Hinshaw, S. P., & Melnick, S. (1995). Peer relationships in boys with attention-deficit hyperactivity disorder with and without comorbid aggression. *Development and Psychopathology*, *7*, 627-647.

Jarrett, M. A., & Ollendick, T. H. (2008). A conceptual review of the comorbidity of attention-deficit/hyperactivity disorder and anxiety: Implications for future research and practice. *Clinical Psychology Review*, *28*, 1266-1280.

Jensen, P., Hinshaw, S., Kraemer, H., Lenora, N., Newcorn, J., & Abikoff, H. (2001). ADHD comorbidity findings from the MTA study: Comparing comorbid subgroups. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*(2), 147-158.

Kagan, J. (1999). *The concept of behavioral inhibition. Extreme fear, shyness, and social phobia: Origins, biological mechanisms, and clinical outcomes*. New York, NY: Oxford University Press.

Kagan, J., Reznick, S., & Snidman, N. (1987). The physiology and psychology of behavioral inhibition in children. *Child Development, 58*, 1459-1473.

Loo, S. K., Humphrey, L. A., Tapio, T., Moilanen, I. K., McGough, J. J., McCracken, J. T., . . . Smalley, S. L. (2007). Executive functioning among Finnish adolescents with attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *46*, 1595-1604.

Maedgen, J. W., & Carlson, C. L. (2000). Social functioning and emotional regulation in the attention deficit hyperactivity disorder subtypes. *Journal of Clinical Child Psychology*, *29*, 30-42.

Martel, M. M. (2009). Research review: A new perspective on attention-deficit/hyperactivity disorder: Emotion dysregulation and trait models. *Journal of Child Psychology and Psychiatry*, *50*, 1042-1051.

Martel, M. M., & Nigg, J. T. (2006). Child ADHD and personality/temperament traits of reactive and effortful control, resiliency, and emotionality. *Journal of Child Psychology and Psychiatry*, *47*, 1175-1183.

Martel, M. M., Nigg, J. T., & von Eye, A. (2009). How do trait dimensions map onto ADHD symptom domains? *Journal of Abnormal Child Psychology*, *37*, 337-348.

Mash, J., & Barkley, R. (2003). *Child psychopathology* (2nd ed.). New York, NY: Guilford.

Melnick, S., & Hinshaw, S. (2000). Emotion regulation and parenting in AD/HD and comparison boys: Linkages with social behaviors and peer preference. *Journal of Abnormal Child Psychology*, *28*, 73-86.

The MTA Cooperative Group. (1999). Multimodal treatment study of children with ADHD: A 14 month randomized clinical trial of treatment strategies for attention-deficit/hyperactivity disorder. *Archives of General Psychiatry*, *56*, 1073-1086.

Nigg, J. T. (2006). Temperament and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, *47*, 395-422.

Nigg, J. T., & Casey, B. J. (2005). An integrative theory of attention-deficit/hyperactivity disorder based on the cognitive and affective neurosciences. *Developmental Psychopathology*, *17*, 785-806.

Nigg, J. T., Goldsmith, H. H., & Sachek, J. (2004). Temperament and attention deficit hyperactivity disorder: The development of a multiple pathway model. *Journal of Clinical Child and Adolescent Psychology*, *33*, 42-53.

Nigg, J. T., Willcutt, E. G., Doyle, A. E., & Sonuga-Barke, J. S. (2005). Causal heterogeneity in attention-deficit/hyperactivity disorder: Do we need neuropsychologically impaired subtypes? *Biological Psychiatry*, *57*, 1224-1230.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Science*, *9*, 242-249.

Pelham, W. E., & Fabiano, G. A. (2008). Evidence-based psychosocial treatment for attention deficit/hyperactivity disorder: An update. *Journal of Clinical Child and Adolescent Psychology*, *37*, 185-214.

Pelham, W. E., Foster, M. E., & Robb, J. A. (2007). The economic impact of attention-deficit/hyperactivity disorder in children and adolescents. *Ambulatory Pediatrics*, *7*, 121-131.

Posner, M. (2004). Progress in attention research. In M. Posner (Ed.), *Cognitive neuroscience of attention* (pp. 1-32). New York, NY: Guilford.

Reynolds, C. R., & Kamphaus, R. W. (2004). *Behavior Assessment System for Children* (2nd ed.). Circle Pines, MN: American Guidance System.

Rothbart, M., & Bates, J. (2006). Temperament. *Handbook of child psychology: Vol. 3, Social, emotional, and personality development*. Hoboken, NJ: Wiley.

Rothbart, M. K., & Posner, M. I. (2006). Temperament, attention, and developmental psychopathology. In D. Cicchetti & D. J. Cohen (Eds.), *Handbook of developmental psychopathology: Revised* (pp. 167-188). New York, NY: Wiley.

Schatz, D. B., & Rostain, A. L. (2006). ADHD with comorbid anxiety: A review of the current literature. *Journal of Attention Disorders*, *10*, 141-149.

Sergeant, J. A., Geurts, H., Huijbregts, S., Scheres, A., & Oosterlaan, J. (2003). The top and the bottom of ADHD: A neuropsychological perspective. *Neuroscience & Biobehavioral Reviews*, *27*, 583-592.

Shields, A., & Cicchetti, D. (1997). Emotion regulation among school-age children: The development and validation of a new criterion Q-sort scale. *Developmental Psychology*, *33*, 906-916.

Sobanski, E., Banaschewski, T., Asherson, P., Buitelaar, J., Chen, W., Franke, B., . . . Faraone, S. V. (2010). Emotional liability in children and adolescents with attention deficit/hyperactivity disorder (ADHD): Clinical correlates and familial prevalence. *Journal of Child Psychology and Psychiatry*, *51*, 915-923.

Sonuga-Barke, E. J. S. (2005). Causal models of ADHD: From common simple deficits to multiple developmental pathways. *Biological Psychiatry*, *57*, 1231-1238.

Spencer, T. (2006). ADHD and comorbidity in childhood. *Journal of Clinical Psychiatry*, *67*, 27-31.

Walcott, C., & Landau, S. (2004). The relation between disinhibition and emotion regulation in boys with attention deficit hyperactivity disorder. *Journal of Clinical Child and Adolescent Psychology*, *33*, 772-782.

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biological Psychiatry*, *57*, 1336-1346.

Author Biographies

Paulo A. Graziano is a postdoctoral fellow at the Center of Children and Families at Florida International University. He has extensive child specialty clinical training in the area of school-based assessments, parent training, and behavioral treatments for children with externalizing disorders. His research expertise lies within the *self-regulation* domain and how it relates to the development of children's externalizing problems, social competence, and school readiness. His research also examines how environmental factors, in particular treatment interventions, can improve children's self-regulation skills and subsequent adaptive functioning.

Joseph P. McNamara is an assistant professor of psychiatry at the University of Florida. His teaching, research, and clinical practice involve children and adolescents with a special emphasis on cognitive behavioral therapy. His research interests focus on the role of executive functioning (EF) and sleep functioning in children and adolescents with internalizing disorders.

Gary R. Geffken is an associate professor of psychiatry at the University of Florida, with additional academic appointments in pediatrics and clinical and health psychology. His teaching, research, and clinical practice involve children and adolescents with a special emphasis on cognitive behavioral therapy and psychological assessments. His research interests and previous publications have centered on treatment of obsessive-compulsive disorder and enuresis as well as on adherence and health status in children and adolescents with difficult-to-manage diabetes.

Adam M. Reid is currently a 2nd-year doctoral student in the department of psychiatry and clinical psychology at the University of Florida. His research focuses on the assessment and classification of pediatric anxiety disorders as well as on the role of temperament and EF in the development and maintenance of internalizing and externalizing disorders.