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Functional Impairment Variability in Children With ADHD Due to Emotional Impulsivity

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Abstract

Objective: The present study utilized ecological momentary assessment (EMA) to examine the effects of emotional impulsivity on overall functional impairment and functional impairment variability (FIV) of children with and without ADHD. **Method:** Parents of 74 children, 8- to 12-year-olds (42 with ADHD, 32 without ADHD), completed EMA assessment protocol ratings of their child's mood (3 times daily) and functional impairment (1 time daily) over the course of 28 days. **Results:** Hierarchical regression analyses supported the interaction of ADHD diagnostic status and greater EMA-derived emotional impulsivity in the estimation of total functional impairment (Total FI) and FIV. Thus, greater emotional impulsivity was found to be related to greater Total FI and FIV among children with ADHD but not among children without ADHD. **Conclusion:** This study suggests that children with ADHD and greater emotional impulsivity demonstrate greater overall levels of functional impairment, with the severity of their impairment varying significantly over time. *(J. of Att. Dis. XXXX; XX(X) XX-XX)*

Keywords

ecological momentary assessment, ADHD, emotional impulsivity, emotion regulation, functional impairment, variable impairment

Functional impairments are difficulties related to the symptoms of a disorder that impact how an individual functions in various developmental contexts (Danckaerts et al., 2010; Deault, 2010). More specifically, functional impairments represent deviations from typical functioning within a specific functional domain (Danckaerts et al., 2010). In childhood, such impairments may manifest through poor academic performance, grade retention problems, negative social behavior, and impaired social and familial relationships (Barkley, 2006; Danckaerts et al., 2010; Deault, 2010; Holbrook et al., 2012). Functional impairments are especially common in individuals with ADHD; as Fabiano and colleagues (2006) noted, "Impairment is a feature of every component of the ADHD diagnosis—the symptoms themselves are only valid indexes of ADHD if they are impairing" (p. 370). To meet criteria for ADHD, an individual must demonstrate symptom-related impairment across multiple contexts (American Psychiatric Association [APA], 2013; Fabiano et al., 2006). Accordingly, children with ADHD generally experience impaired functioning in the home, school, and social environments, and demonstrate more negative self-perceptions. While the core symptoms of ADHD undoubtedly contribute to impairment, it is possible that other associated aspects of ADHD may contribute as well.

ADHD and Functional Impairment

ADHD is a neurological disorder characterized by pervasive patterns of inattention, hyperactivity, and impulsivity (APA, 2013). The symptoms of ADHD are often associated with aggression, poor inhibitory and impulse control, poor delay of gratification, learning difficulties, and low motivation to engage in or follow through on tasks (Barkley, 2006). These core symptoms and associated difficulties often result in children with ADHD demonstrating higher rates of functional impairment than their typically developing peers (Barkley, 2006; Fabiano et al., 2006). Children with ADHD as young as age 3 demonstrate significantly higher levels of functional impairment than peers across multiple functional domains, suggesting that impairment is present even when the environmental demands are relatively low (Dupaul, McGoey, Eckert, & VanBrakle, 2001).

Previous research suggests that children with ADHD are approximately 10 times more likely than typically

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functioning children to demonstrate significant impairment that interferes with their home life, peer relationships, and academic performance (Strine et al., 2006). Indeed, families of children with ADHD tend to experience more problematic family functioning (Deault, 2010; Johnston & Mash, 2001), higher levels of overall family stress (Deault, 2010; DuPaul et al., 2001; Johnston & Mash, 2001), and more strained parent–child relationships (Deault, 2010; Johnston & Mash, 2001). Academically, children with ADHD often have more difficulty managing their coursework (Evans, Sibley, & Serpell, 2009; Langberg, Epstein, Becker, Girio-Herrera, & Vaughn, 2012; Power, Werba, Watkins, Angelucci, & Eiraldi, 2006) in addition to understanding and mastering course material (Thorell, 2007). Not surprisingly, these children are more likely to experience decreased scholastic performance and poor academic standing (Barkley, 2006). In addition, Barkley (2006) theorized that the self-regulation difficulties of children with ADHD result in them engaging in fewer prosocial behaviors when interacting with peers. Accordingly, these children often experience elevated rates of peer rejection (Hoza, 2007; Hoza et al., 2005), peer victimization (Wiener & Mak, 2009), and bullying (Bacchini, Affuso, & Trotta, 2008; Unnever & Cornell, 2003). Perhaps partially due to the negative feedback children with ADHD receive from family, teachers, and peers, impairment in these children is associated with a heightened risk for developing a negative self-concept, depression, and low self-esteem (Edbom, Lichtenstein, Granlund, & Larsson, 2006).

ADHD and Emotional Impulsivity in Relation to Functional Impairment

Although the core symptoms of ADHD appear to be strongly associated with concordant functional impairment, evidence suggests that emotion dysregulation contributes to impairment above and beyond the core symptoms of ADHD (Barkley, 2010). Emotion dysregulation is a broad and multifaceted construct that may manifest in various patterns of difficulty. One pattern of emotion dysregulation that has been identified in children with ADHD is emotional impulsivity (Anastopoulos et al., 2011; Barkley & Fischer, 2010; Sobanski et al., 2010). Emotional impulsivity is a "specific pattern of rapid and intense shifts in emotional states resulting from frequent 'impulsive' [and] intense emotional reactions to positive and negative stimuli" (Rosen, Walerius, Fogleman, & Factor, n.d.). Research has demonstrated that children with ADHD exhibit greater emotional impulsivity than children without ADHD (Jensen & Rosen, 2004; Norvilitis, Casey, Brooklier, & Bonello, 2000; Walcott & Landau, 2004), as evidenced by more intense responses to emotional stimuli (Jensen & Rosen, 2004), more difficulty inhibiting negative emotional responses (Walcott & Landau, 2004), and more extreme shifts in emotional states (Norvilitis et al., 2000). Few studies have examined emotional impulsivity outside of the context of ADHD. However, Rosen and colleagues (n.d.) found that children with and without ADHD did not significantly differ in rates of emotional impulsivity.

It is important to note that not all children with ADHD demonstrate emotional impulsivity; however, it is likely that children with ADHD and emotional impulsivity experience more functional impairment than children with ADHD who do not demonstrate patterns of emotional impulsivity (Anastopoulos et al., 2011; Barkley, 2006; Barkley & Fischer, 2010; Fabiano et al., 2006). Among children with ADHD, emotional impulsivity is associated with peer rejection and negative social experiences (Maedgen & Carlson, 2000; Melnick & Hinshaw, 2000; Sobanski et al., 2010), familial conflict and parental stress, and strained teacher–child relationships (Barkley, 2010). A study by Anastopoulos and colleagues (2011) found that parent-report measures of emotional impulsivity mediated the relationship between ADHD and functional impairment across multiple domains. Anastopoulos and colleagues suggested that this finding was due to children with ADHD and emotional impulsivity demonstrating extreme emotional reactions to everyday experiences combined with a decreased ability to actively regulate emotions due to the core symptoms of ADHD. Similarly, Rosen and colleagues (n.d.) noted that greater emotional impulsivity was associated with emotional and behavioral difficulties among children with but not without ADHD, suggesting that it may be the interaction of emotional impulsivity with ADHD symptoms that results in impairment.

ADHD and Inconsistent Performance, Behavior, and Emotionality

Research strongly supports that children with ADHD demonstrate *variability* in performance rather than consistently poor performance. Indeed, inconsistent within-domain functioning across settings is a hallmark of ADHD (Anastopoulos et al., 2011). For instance, children with ADHD often demonstrate more inconsistent daily performance on classroom tasks and homework than their peers (DuPaul & Stoner, 2002, 2003), and demonstrate a broader range of stimuli-seeking, physical behaviors than peers when in a non-stimulating environment (Antrop, Roeyers, Van Oost, & Buysse, 2000). This variability is perhaps most evident during neuropsychological tests, as children with ADHD have consistently demonstrated more inconsistent performance across a range of cognitive and neuropsychological performance tasks (Epstein et al., 2003; Kofler et al., 2013). Taken together, such findings suggest that the symptoms of ADHD result in inconsistent performance across various cognitive and behavioral domains.

This variability in children with ADHD is also evident in the emotional domain. Emotional impulsivity describes a pattern of variable emotional functioning often observed in this population (Anastopoulos et al., 2011; Sobanski et al., 2010). According to parent and teacher reports, emotional impulsivity is expressed as emotional reactivity to everyday stimuli that manifests in the form of "higher emotional highs and lower emotional lows" (Anastopoulos et al., 2011, p. 584). Poorly regulated emotions are predictive of negative behavior and functional impairment, particularly among children with poor attentional control (Eisenberg et al., 2000). Children's awareness of their impaired performance from situation to situation may then exacerbate their negative emotional state, creating a cycle in which emotional distress impairs performance, with the consequences of the impaired performance in turn resulting in further emotional distress.

Currently, there has been little research on variability in functional impairment for children with ADHD. However, Fabiano and colleagues (2006) found that there may be variability in both the degree of impairment across children with ADHD and in which domains of functioning are impaired among these children. According to Fabiano and colleagues, impairment ratings of children with ADHD on the Impairment Rating Scale (IRS; Fabiano et al., 2006) demonstrated significant variability across and within children and were negatively skewed, as opposed to children without ADHD whose ratings were positively skewed and less variable. This indicated that the children with ADHD as a whole had more severe and variable impairment than children without ADHD, who typically had ratings clustering in the "little to no problem" range. Although these findings suggest that there is variability in impairment for children with ADHD, they do not provide insight into whether individual children with ADHD vary in impairment on a daily basis and what factor(s) potentially contribute to that variation. Notably, Eisenberg and colleagues (2000) indicated that poor attentional control was only associated with problem behavior in the context of negative emotionality, suggesting that impairment across functional domains may be comparatively lower among children with ADHD when they are experiencing less emotional distress. Thus, variable and impulsive emotions may be more likely to covary with variability in functional impairment.

Hypotheses

As noted in the previous section, evidence suggests that functional impairment varies across time, domain, and setting among children with ADHD (Fabiano et al., 2006). Emotional difficulties are among the contributing factors to functional impairment (Anastopoulos et al., 2011); thus, it stands to reason that children with ADHD who are more emotionally impulsive will also have greater and more variable functional impairment. Studies have yet to examine how emotional impulsivity over time may relate to *variability* of functional impairment and how these relations may differ among children with and without ADHD. Given the evidence of functional impairment variability (FIV) among children with ADHD (Fabiano et al., 2006), and the finding that attentional control only predicted poor behavioral functioning in the presence of negative emotionality (Eisenberg et al., 2000), it was expected that emotional impulsivity would be associated with both overall functional impairment and day-to-day *variability* of functional impairment among children with ADHD. It was unclear whether this association would be evident in children without ADHD. Thus, a moderation model was proposed to determine whether it was the main effect of emotional impulsivity or the interaction of ADHD and emotional impulsivity that drove the association between emotional impulsivity and total functional impairment (Total FI)/FIV. The following hypotheses were proposed:

Hypothesis 1: Children with ADHD would demonstrate greater Total FI and FIV than children without ADHD.
Hypothesis 2: Children with ADHD would demonstrate a relationship between emotional impulsivity and Total FI/FIV, such that greater emotional impulsivity would be associated with greater Total FI and FIV. Exploratory analyses would determine if this relation was consistent between children with and without ADHD.

Method

Participants

Seventy-four children (46 boys, 28 girls) aged 8 to 12 years (M age = 9.85, SD age = 1.19) participated in the present study. Participants included 42 children with ADHD (13 girls, 29 boys, M age = 9.67, SD age = 1.16) and 32 children without ADHD (15 girls, 17 boys; M age = 10.06, SD age = 1.22). The ratio of males to females (2.2:1) within the ADHD sample is consistent with the gender discrepancy in children with ADHD (APA, 2013). All participants were recruited through advertisements distributed to elementary and middle schools in a mid-sized Midwestern metropolitan area. To maintain consistency across ecological momentary assessment (EMA) protocol, eligibility was limited to children who resided in a single home (i.e., single-parent or two-parent family) full-time over the course of the study. This ensured that all ratings for each participant occurred in a single residential setting. In addition, given Barkley's (2010) theory that emotional impulsivity is present in children with ADHD-Combined Type and children within the ADHD-Inattentive subtype who demonstrate a sub-threshold level of hyperactive/impulsive symptoms, but is not present in children with a "sluggish cognitive tempo" presentation of

ADHD-Inattentive type, children with the ADHD-Inattentive subtype were only included in the study if they met criteria for at least three hyperactive/impulsive symptoms. The Diagnostic Interview Schedule for Children–Parent Report (DISC-P; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000) was used to assess for the status of ADHD and other emotional/behavioral disorders.

Within the ADHD group, 31 children met full diagnostic criteria for Combined Type and 11 children met full diagnostic criteria for Inattentive subtype on the DISC-P (Shaffer et al., 2000). Of the 42 children with ADHD, 24 were receiving pharmaceutical treatment for ADHD. Medication status and dose remained constant for all participants throughout the study.

Participants without an ADHD diagnosis represented a community sample as opposed to a healthy control sample. Therefore, children were not excluded from the study if they demonstrated some symptoms of ADHD but did not meet full diagnostic criteria. Parents of children in the non-ADHD group endorsed their children as demonstrating 0 to 5 symptoms of inattention ($M = 1.39$, $SD = 1.65$) and 0 to 5 symptoms of hyperactivity/impulsivity ($M = 0.71$, $SD = 1.35$) on the DISC-P.

To guarantee that the non-ADHD sample represented a true community sample, children in the non-ADHD group were retained in the study regardless of whether they met criteria for disorders other than ADHD. The DISC-P was used to assess for behavioral (Oppositional Defiant Disorder [ODD]), mood (Major Depressive Disorder), and anxiety (Social Phobia, Separation Anxiety, Obsessive Compulsive Disorder [OCD], Generalized Anxiety Disorder [GAD], and Panic Disorder) disorders in both the ADHD and non-ADHD groups. Of the 32 non-ADHD children, only 6 children met criteria for at least one behavioral (2 with ODD), mood (0 with Major Depressive Disorder), or Anxiety Disorder Diagnosis (1 with Social Phobia, 1 with Separation Anxiety, 1 with OCD, and 1 with GAD). In contrast, of the 42 children with ADHD, 24 met criteria for at least one comorbid behavioral (22 with ODD), mood (3 with Major Depressive Disorder), or Anxiety Disorder (8 with Separation Anxiety, 4 with OCD, 3 with GAD, and 3 with Social Phobia).

Of the participants involved in the study, 64.9% identified as Caucasian/White, 27.0% identified as African American/Black, 4.1% identified as Latino/Hispanic, and 4.1% identified as biracial. This ethnic composition is representative of the area from which the population was sampled (U.S. Census Bureau, 2010). The ethnic composition and demographic information of the ADHD and non-ADHD diagnostic groups are summarized in Table 1.

Table 1. Demographic and Racial/Ethnic Distribution for ADHD and Non-ADHD Diagnostic Groups.

	ADHD ($n = 42$)	Non-ADHD ($n = 32$)
M age	9.67	10.06
Gender (males)	29 (69.0%)	17 (53.1%)
Comorbid Disorders	24 (57.1%)	6 (18.8%)
Race/ethnicity		
Caucasian/White	25 (59.5%)	23 (71.9%)
African American/Black	12 (28.6%)	8 (25.0%)
Latino/Hispanic	3 (7.1%)	0
Biracial	2 (4.8%)	1 (3.1%)

Procedures

This study was conducted as part of a larger data collection; thus, only procedures relevant to the present study are described. During the baseline session, parents provided consent preceding study procedures. To assess diagnostic status of the child, parents completed the DISC-P (Shaffer et al., 2000). Parents were then trained in how to complete the EMA protocol. Parents were provided US$15 compensation for completing the baseline session.

EMA Protocol

EMA is a methodological procedures used to collect real-time data from participants as they go about their typical daily activities over time. EMA provides response data that are more accurate than retrospective recall due to its lack of reliance on memory (Stone & Shiffman, 1994). In addition, Ebner-Priemer and Trull (2009) insisted that to accurately measure patterns of variability (such as emotional impulsivity or FIV), methodologies (e.g., EMA) that account for intensity, variability, and temporal dependency must be employed. Previous studies have successfully utilized EMA to assess emotional variability and impulsivity in children with and without ADHD (Rosen & Factor, 2012; Rosen et al., n.d.; Suveg, Payne, Thomassin, & Jacob, 2010; Whalen et al., 2009). Two studies have also indicated that child ratings are not appropriate for measuring emotional impulsivity over time due to children being less likely to complete EMA ratings at times when they are experiencing distress (Rosen, Epstein, & Van Orden, 2013; Rosen & Factor, 2012). Thus, in the present study EMA was selected to measure parent ratings of children's emotional impulsivity, Total FI, and FIV. Child ratings of these variables were not assessed.

Participants completed ratings using Palm Tungsten E2 Personal Data Assistants (PDA), which were programmed with Purdue Momentary Assessment Tool (PMAT) software (Weiss, Beal, Lucy, & MacDermid, 2004). Each day, the PDA set off alerts at three specific predetermined intervals (i.e., before school, after school, and evening) requested by parents to be compatible with the family schedule within specific time windows (between 7 and 10 a.m., between 3

and 6 p.m., and between 6 and 9 p.m.). Predetermined (rather than random) time points were necessary to ensure that parents were in the presence of their children while completing ratings to allow for "spot-moment" assessments of the child's mood. The 3 time points for each day were selected by parents to ensure that the EMA protocol did not interfere with their families' schedules. EMA data were collected from parents 3 times a day for 28 days, resulting in a total of 84 time points. Parents were informed that EMA intervals were to be completed exclusively by the parent who had completed baseline questionnaires. At each rating time point, the rater indicated their relationship with the child (i.e., mother, father, other caretaker) to determine whether the designated parent had completed the ratings. In addition, at each time point, parents were also asked to complete a 10-item version of the Positive and Negative Affect Scale–Parent Report (PANAS-PR; Phillips, Lonigan, Driscoll, & Hooe, 2002) to indicate their perception of their child's affect at the time immediately preceding the PDA alert. This 10-item version of the PANAS was based on the items from Thompson's (2007) 10-item PANAS–Short form. Parents also completed items from the IRS (Fabiano et al., 2006) at the end of each day to indicate the degree of their child's impairment across functional domains during that day.

To increase adherence to the EMA protocol, parents could earn additional compensation up to US$10 (US$40 over 4 weeks), commensurate with their completion of EMA ratings. Compensation was dependent on the percentage of ratings completed at the cessation of the week. To collect palm data, assess rating completion percentage, and determine amount payable to participants for the week, parents were asked to attend weekly follow-up visits at the laboratory. During these sessions, parents were permitted to request changes to weekly alert schedules. Such changes were permitted to increase adherence to EMA protocol and prevent disruptions to the participants' daily lives. All study procedures were approved by the local Institutional Review Board.

Measures

DISC-P. During the baseline session, parents were administered the DISC-P (Shaffer et al., 2000), a diagnostic structured interview that assesses child diagnoses using parent responses to determine whether the child meets *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; APA, 1994) criteria for a number of psychological disorders. The DISC-P was used to determine the child's diagnostic status by assessing for the presence of diagnostic symptoms and the degree of impairment caused by symptoms. Research indicates that the DISC-P is considered reliable and valid across numerous settings (Shaffer et al., 2000).

PANAS-PR. The PANAS-PR (Phillips et al., 2002) was administered 3 times daily for 28 days in conjunction with the EMA protocol to assess total affect and affective change in children. A 10-item PANAS-PR was created for this study by adapting items from Thompson's (2007) 10-item, adult self-report, PANAS–Short form using analog items from the 20-item PANAS-PR. Thompson found that the 10-item PANAS is psychometrically equivalent to the full version. Thus, the 10-item PANAS-PR was utilized in this study to minimize the inconvenience and time commitment of the EMA component of the study. Previous studies have demonstrated the utility of the 10-item PANAS-PR for assessing emotional impulsivity within an EMA methodology (Rosen & Factor, 2012).

Parents rated the degree to which their child demonstrated listed emotions at that specific time point on a 5-point Likert-type scale from 1 (*not at all*) to 5 (*extremely*). Mean Total Affect scores were created by averaging the scores from the PANAS-PR across each time point, which signified the child's average total affective intensity across all time points. Mean squared successive difference (MSSD) scores were created by following the procedures recommended by Solhan, Trull, Jahng, and Wood (2009). Thus, MSSD Total Affect scores were calculated by taking the difference of each successive within-day rating point (i.e., morning–afternoon and afternoon–evening), squaring each within-day difference score, and averaging the within-day MSSDs across all days in which the participant completed EMA ratings. This process creates a single MSSD Total Affect score per participant that accounts for the frequency and amplitude of within-day variability over the 28-day measurement period. Prior research has demonstrated the reliability and validity of using MSSD scores to assess variability within EMA data (Jahng, Wood, & Trull, 2008).

IRS. The IRS (Fabiano et al., 2006) is a scale used to measure a child's degree of impairment across several domains of functioning. In conjunction with the EMA, the IRS was used to measure the child's functional impairment once daily over the span of 4 consecutive weeks. The IRS is a parent-report measure in which parents rate the degree to which their child is experiencing problems with academics, peers, siblings, parents, self-esteem, and overall family functioning on a 6-point Likert-type scale, ranging from 1 (*not a problem*) to 6 (*extreme problem*). Mean scores were calculated across IRS domains (academics, peer, parent, self-esteem, and family functioning) for each time point to provide a single estimate of overall domain-independent functional impairment at each time point. The item assessing relationship problems with siblings was not included in the calculation of mean total IRS because some participants did not have siblings. A Total FI score was calculated by averaging the overall functional impairment scores at each time point. The overall functional impairment scores at

each time point were also used to create MSSD scores. MSSDs were created from the IRS to demonstrate the child varying levels of impairment by taking the difference of each successive rating point (i.e., Day 1, Day 2, Day 3, etc.), squaring each difference score, and averaging the difference scores.

Results

EMA Protocol Adherence

Before creating EMA variables based on PANAS ratings, each rating time point was examined to guarantee that it was completed by the designated rater in the presence of the child. Time points were removed from the data set if either of these conditions were violated (i.e., completed while child was asleep or not physically present; completed by a person other than the primary rater). Parents completed an average of approximately 89% of the 84 possible assessment intervals (*SD* = 9.24%, minimum = 67%, maximum = 100%) and 88% of the 28 possible IRS intervals (*SD* = 8.00%, minimum = 57%, maximum = 100%; all adherence data calculated *after* inappropriate time points were removed). Overall, most of the parents demonstrated necessary adherence to the EMA protocol. All participants included in analyses completed at least 2 weeks of the EMA protocol. Three participants were excluded from the study due to insufficient EMA completion—two families of children with ADHD and one family of a child without ADHD. A one-way ANOVA indicated a significant difference in gender, such that children of the families who failed to complete at least 2 weeks of the EMA protocol were significantly more likely to be female than the children of the families who completed the EMA protocol, $F(1, 75) = 4.80$, $p = .032$. No significant differences on any other demographic variables were noted, $F(1, 75) = .001$ to 1.43, ps = .23 to .97; thus, no data are included for these families in either the "Participants" section or the "Results" section. All data were analyzed using SPSS® 21 software.

Hypothesis 1: Children with ADHD would demonstrate higher Total FI and FIV than children without ADHD.

Two ANCOVAs were conducted to determine whether the Total FI and FIV were specific to children with ADHD. In both analyses, gender, age, and active ADHD medication use were entered as covariates, with ADHD included as an independent variable and IRS total mean (Total FI) or IRS total MSSD (FIV) entered as the dependent variable. Analyses supported ADHD as a predictor of Total FI, $F(1, 69) = 7.67$, $p = .007$, $\eta_p^2 = .10$; and FIV, $F(1, 68) = 4.84$, $p = .031$, $\eta_p^2 = .07$, after controlling for the effects of age, gender, and active ADHD medication use.

Hypothesis 2: ADHD would moderate the relation of emotional impulsivity to both concordant Total FI and concordant FIV.

Bivariate analyses. Initial bivariate analyses (see Table 2) were conducted to assess the relation of ADHD and the EMA-derived measures of emotional impulsivity (i.e., parent-reported PANAS total affect MSSD) to EMA-derived measures of functional impairment (i.e., parent-reported IRS total mean) and FIV (i.e., parent-reported IRS total MSSD). No point-biserial correlation was observed between ADHD diagnostic status and parent-reported Total Affect MSSD, $r(72) = .10$, $p = .39$, indicating that ADHD diagnostic status was not related to emotional impulsivity in the present study. Indeed, an independent-samples *t* test confirmed that the ADHD ($M = 106.40$, $SD = 53.44$) and non-ADHD ($M = 95.80$, $SD = 50.90$) groups did not significantly differ in terms of emotional impulsivity, $t(72) = .87$, $p = .388$. Significant correlations were observed between ADHD diagnostic status and parent-reported Total FI, $r(72) = .49$, $p < .001$, and parent-reported FIV, $r(72) = .44$, $p < .001$, indicating that ADHD was associated with significantly greater overall functional impairment and more variable functional impairment. Two independent-samples *t* tests confirmed these findings (see Table 3). Significant moderate correlations were also observed between parent-reported emotional impulsivity and both parent-reported Total FI, $r(72) = .25$, $p = .031$, and FIV, $r(72) = .27$, $p = .019$, indicating that greater emotional impulsivity was significantly related to greater Total FI and FIV.

While these analyses provided encouraging evidence regarding the relation of emotional impulsivity to Total FI and FIV in children, previous research suggests that there are higher rates of functional impairment in children with versus without ADHD (Barkley, 2006; Fabiano et al., 2006; Strine et al., 2006). Thus, it seemed probable that there may also be a differential pattern of association between emotional impulsivity and functional impairment among children in these two groups. Separate bivariate correlation analyses were therefore rerun examining the relation of emotional impulsivity to Total FI and FIV among children with and without ADHD. Among children with ADHD, emotional impulsivity continued to demonstrate moderate correlations to Total FI, $r(40) = .37$, $p = .016$, and FIV, $r(40) = .45$, $p = .003$, suggesting that emotional impulsivity is moderately related to Total FI and FIV in children with ADHD. However, among children without ADHD, emotional impulsivity demonstrated minimal relation to Total FI, $r(30) = -.06$, $p = .740$, and FIV, $r(30) = -.15$, $p = .41$.

Multivariate analyses. Two multivariate hierarchical linear regression analyses were conducted to examine the effect of parent-reported EMA-derived emotional impulsivity and ADHD on parent-reported EMA-derived Total FI and FIV,

Table 2. Bivariate Correlations of Emotional Impulsivity, ADHD Status, Functional Impairment, and Functional Impairment Variability (N = 74).

Measure	1	2	3	4
EMA-derived measures				
1. Parent-report Total Affect MSSD (emotional impulsivity)	—			
Diagnostic status				
2. ADHD status (0 = non-ADHD, 1 = ADHD)	.10	—		
Retrospective report measures				
3. IRS mean total	.25*	.49***	—	
4. IRS total MSSD (functional impairment variability)	.27*	.44***	.69***	—

Note. EMA = ecological momentary assessment; MSSD = mean squared successive difference; IRS = Impairment Rating Scale.
†p < .10. *p < .05. **p < .01. ***p < .001.

Table 3. Mean Differences Between ADHD and Non-ADHD Diagnostic Groups on Emotional Impulsivity and Functional Impairment Variables.

	ADHD mean (n = 42)	Non-ADHD mean (n = 32)	t	p
PANAS 10 Total mean	39.19	38.57	0.45	.654
PANAS 10 Total MSSD	106.40	95.80	0.87	.388
IRS mean	10.60	7.56	4.72	.000
IRS MSSD	34.91	10.31	4.18	.000

Note. df = 72; PANAS = Positive and Negative Affect Scale; MSSD = mean squared successive difference; IRS = Impairment Rating Scale.

as well as to examine the interaction of ADHD and emotional impulsivity. Both Total FI (IRS total mean) and FIV (IRS total MSSD) were regressed on the EMA-derived indicator of emotional impulsivity (parent-reported PANAS Total Affect MSSD), ADHD, and an ADHD × Emotional impulsivity interaction term. Age, gender, and active ADHD medication use were entered into the first step to control for factors that are known to be associated with higher rates of functional impairment in children with ADHD. PANAS Total Affect MSSD scores and ADHD diagnostic status were entered into the second step to assess whether there was a main effect of emotional impulsivity or ADHD diagnostic status on Total FI and FIV when controlling for gender, age, and active ADHD medication use. An ADHD × Emotional impulsivity interaction term was entered into the third step to assess for the differential impact of emotional impulsivity on the variability of overall functional impairment of children with ADHD versus children without ADHD. Akaike information criterion (AIC) was used to assess model fit, with ΔAIC signifying the difference between the AIC with the inclusion of ADHD, emotional impulsivity, and the ADHD × Emotional impulsivity interaction term and the next best fitting model. Negative ΔAIC scores indicated lower AIC and thus improved fit for the inclusion of the main effects and/or the interaction term in the overall model.

Relation of emotional impulsivity and ADHD diagnostic status to Total FI. Results moderately supported the hypothesis that emotional impulsivity was differentially linked to Total FI among children with ADHD but not among children without ADHD (see Table 4 and Figure 1). Examination of the covariates entered into the first step suggested that they contributed significantly to model fit, ΔR^2 = .182, p = .003, AIC = 160.68. Specifically, results indicated a significant impact of active ADHD medication use (β = .37, t = 3.41, p = .001), such that greater Total FI was evident among children who were actively receiving ADHD medication treatment during the study. Results also indicated a significant contribution of the main effects of ADHD diagnostic status and emotional impulsivity to the estimation of Total FI, ΔR^2 = .126, p = .003, AIC = 152.30, ΔAIC = −8.38, such that children with ADHD (β = .35, t = 2.68, p = .009) and children with higher PANAS Total Affect MSSD scores (β = .21, t = 2.08, p = .041) had greater parent-reported Total FI. However, results suggested the model fit was moderately significantly improved by inclusion of an emotional impulsivity × ADHD interaction term in the estimation of Total FI, ΔR^2 = .039, p = .050, AIC = 150.02, ΔAIC = −2.28, such that emotional impulsivity was moderately linked to greater parent-reported Total FI among children with, but not without, ADHD, β = .29, t = 2.00, p = .050. The overall model was well fit to the estimation of Total FI, R^2 = .347, $F(6, 67)$ = 5.923, p < .001.

Relation of emotional impulsivity and ADHD diagnostic status to FIV. Results strongly supported the hypothesis that emotional impulsivity was differentially linked to FIV among children with ADHD but not among children without ADHD (see Table 5 and Figure 2). Examination of the covariates entered into the first step suggested that they contributed significantly to model fit for FIV, ΔR^2 = .250, p < .001, AIC = 477.732. Specifically, greater parent-reported FIV was observed among males (β = −.31, t = −2.95, p = .004) and among children receiving active ADHD medication treatment (β = .36, t = 3.41, p = .001). Results also indicated a significant contribution of the main effects of ADHD diagnostic status and emotional impulsivity to the estimation of FIV, ΔR^2 = .117, p = .003, AIC = 469.214, ΔAIC = −8.52, such that children with ADHD (β = .26, t = 2.10, p = .039) and children with higher PANAS Total

Table 4. Hierarchical Regression Estimating Mean Functional Impairment (IRS Mean Total Score) by ADHD × Emotional Impulsivity (Parent-Report PANAS Total Affect MSSD; $N = 74$).

Step/variable	R^2	ΔR^2	AIC	*B*	*SE B*	*t*	β
Step 1	.187	.18**	160.68				
Gender (male = 0, female = 1)				−0.68	0.70	−0.97	−.11
Age				−0.29	0.28	−1.03	−.11
Stimulant medication use (no = 0, yes = 1)				2.48	0.73	3.41	.37**
Step 2	.31	.13**	152.30				
ADHD (Non-ADHD = 0, ADHD = 1)				2.17	0.81	2.68	.35**
Emotional impulsivity				0.01	0.01	2.08	.21*
Step 3	.35	.04†	150.02				
Emotional impulsivity × ADHD				0.02	0.01	2.00	.29†

Note. IRS = Impairment Rating Scale; PANAS = Positive and Negative Affect Scale; MSSD = mean squared successive difference; AIC = Akaike information criterion.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

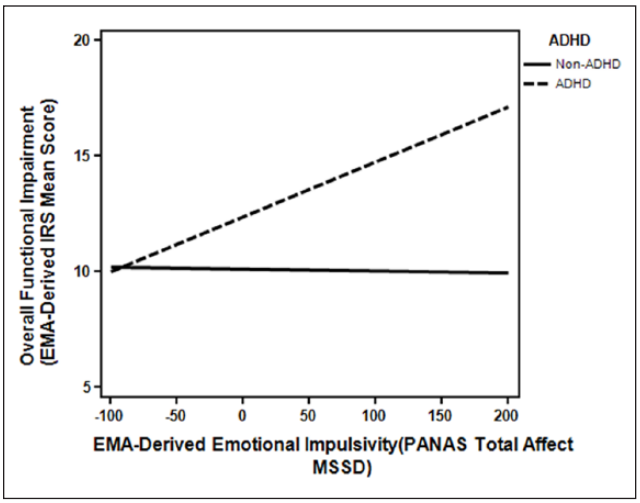

Figure 1. ADHD × Emotional impulsivity in the estimation of overall functional impairment.
Note. EMA = ecological momentary assessment; IRS = Impairment Rating Scale; PANAS = Positive and Negative Affect Scale; MSSD = mean squared successive difference.

Affect MSSD scores (β = .26, $t = 2.69$, $p = .009$) had greater reported FIV. However, results suggested the model fit was significantly improved by inclusion of an Emotional impulsivity × ADHD interaction term in the estimation of FIV, $\Delta R^2 = .050$, $p = .020$, AIC = 465.17, ΔAIC = −4.04, such that emotional impulsivity was linked to greater FIV among children with, but not without, ADHD, β = .32, $t = 2.39$, $p = .020$. The overall model was well fit to the estimation of FIV, $R^2 = .42$, $F(6, 67) = 7.98$, $p < .001$.

Discussion

The current findings support the assumption that emotional impulsivity is a significant contributor to concurrent overall functional impairment and FIV among children with ADHD. As hypothesized, children with ADHD demonstrated significantly greater overall functional impairment than children without ADHD. This finding is consistent with previous research that has demonstrated greater functional impairment in children with ADHD compared with their typically developing peers (Barkley, 2006; Fabiano et al., 2006). Of note, the present study built upon previous research by demonstrating this pattern of impairment over a span of 28 days of continuous reporting, whereas previous studies had only used retrospective reporting. In addition, children with ADHD also demonstrated significantly greater FIV than children without ADHD. Previous research has indicated that children with ADHD demonstrate a less homogeneous pattern of functional impairment than children without ADHD. Fabiano and colleagues (2006) found that children with ADHD demonstrated varying patterns of functional impairment, with each child demonstrating a unique pattern of high and low functional impairment across domains. This resulted in the children with ADHD having greater overall functional impairment than their non-ADHD counterparts, who were generally rated as demonstrating minimal impairment across all domains of functioning examined (Fabiano et al., 2006). The current study extends such findings by demonstrating that the overall functional impairment of a child with ADHD varies significantly more over time than the functional impairment of a child without ADHD.

Consistent with previous research using EMA to measure emotional impulsivity, no significant difference was observed in the emotional impulsivity of children with and without ADHD (Rosen et al., n.d.). Instead, results indicated that emotional impulsivity was differentially related to the overall functional impairment and FIV of children with and without ADHD. Specifically, results suggested that emotional impulsivity is significantly related to concurrent overall functional impairment and FIV among children with ADHD, but is not related to overall functional impairment or FIV among children without ADHD. These findings suggest

Table 5. Hierarchical Regression Estimating Functional Impairment Variability (IRS Total MSSD) by ADHD × Emotional Impulsivity (Parent-Report PANAS Total Affect MSSD; *N* = 74).

Step/variable	R^2	ΔR^2	AIC	*B*	*SE B*	*t*	β
Step 1	.25	.25***	477.73				
Gender (male = 0, female = 1)				−17.51	5.94	−2.95	−.31**
Age				−0.19	2.42	−0.08	−.01
Stimulant medication use (no = 0, yes = 1)				21.09	6.18	3.41	.36**
Step 2	.37	.12**	469.21				
ADHD (Non-ADHD = 0, ADHD = 1)				14.44	6.87	2.10	.26*
Emotional impulsivity				.14	.05	2.69	.26**
Step 3	.42	.05*	465.17				
Emotional impulsivity × ADHD				0.25	0.10	2.39	.32*

Note. IRS = Impairment Rating Scale; MSSD = mean squared successive difference; PANAS = Positive and Negative Affect Scale; AIC = Akaike information criterion.
†*p* < .10. *p < .05. **p < .01. ***p < .001.

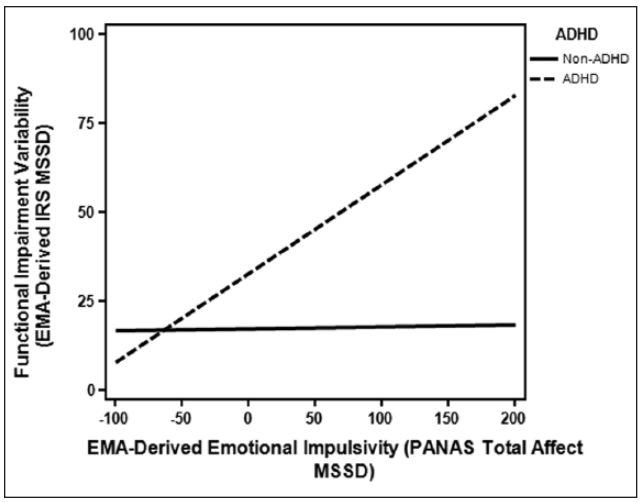

Figure 2. ADHD × Emotional impulsivity in the estimation of functional impairment variability.
Note. EMA = ecological momentary assessment; MSSD = mean squared successive difference; PANAS = Positive and Negative Affect Scale.

that it is the interaction of ADHD and emotional impulsivity, rather than either the core deficits of ADHD or emotional impulsivity alone, that accounts for the concurrent association with overall functional impairment and FIV. Thus, children with ADHD who demonstrated greater emotional impulsivity tended to demonstrate greater overall functional impairment and FIV. Overall functional impairment and FIV did not vary among children without ADHD as a function of emotional impulsivity. Notably, minimal functional impairment was evidenced by children without ADHD in the current study despite the presence of a broad range of emotional impulsivity. Based on these findings, it appears that variability in functional impairment over time is related to the intense and frequent shifts in affect that characterize emotional impulsivity among children with ADHD. In addition, as in previous studies (Anastopoulos et al., 2011; Graziano, McNamara, Geffken, & Reid, 2013; Rosen & Factor, 2012), this inconsistency in emotionality appears to be related to higher levels of overall functional impairment in children with ADHD.

Implications

Theoretical implications. The present study supports the contention that a significant portion of functional impairment in children with ADHD is related to emotional impulsivity (Anastopoulos et al., 2011; Barkley, 2010; Maedgen & Carlson, 2000; Melnick & Hinshaw, 2000; Sobanski et al., 2010). Conversely, results suggested that children without ADHD are able to manage frequent and intense shifts in emotionality such that it does not significantly impact their functioning in other domains. Such findings may be due to the core deficits (i.e., inattention, hyperactivity, and impulsivity) and associated behavioral difficulties (i.e., poor inhibitory and impulse control, poor delay of gratification, etc.; Barkley, 2006) of children with ADHD making it more challenging for these children to resist the urge to behave in accordance with their emotionality, resulting in variable behavior and functional impairment. For instance, it is likely that when children with ADHD experience emotional distress, they have more difficulty managing their responsibilities and social interactions due to their higher level cognitive and regulatory skills being less developed than their typically developing peers. These deficits result in children with ADHD experiencing greater difficulty inhibiting their emotional reactions, which causes them to engage in more emotionally driven behavior that interferes with their functional performance in academic, family, and social settings. This would explain why parents of children with ADHD describe their children as demonstrating an inconsistent pattern of good or bad days.

More generally, the present study supports the growing body of literature indicating that individuals with ADHD demonstrate a consistent pattern of inconsistency across multiple measurable domains (Anastopoulos et al., 2011; Epstein et al., 2003; Hoffman & Dupaul, 2000; Sobanski et al., 2010). The findings of this study indicate that the variability demonstrated by individuals with ADHD goes beyond academic performance (DuPaul & Stoner, 2002, 2003) and neurological findings (Epstein et al., 2003; Kofler et al., 2013), and extends to emotionality, behavior, and general functioning. Such findings may support re-conceptualizing ADHD as a disorder characterized by variable rather than static impairments.

Although the findings suggest that greater functional impairment and FIV are associated with all children with ADHD, they also suggest that a subset of emotionally dysregulated children with ADHD (Anastopoulos et al., 2011; Rosen & Factor, 2012) demonstrate even greater functional impairment and FIV than children with ADHD who are not emotionally dysregulated. Previous research has demonstrated that this subset of emotionally dysregulated children with ADHD have a higher rate of internalizing and externalizing problems (Rosen et al., n.d.) and comorbid diagnoses (Factor, Reyes, & Rosen, 2014) than other children with ADHD and children without ADHD. Such findings may suggest that there is a more severe form of ADHD that is associated with more unpredictable emotions and behaviors and greater and more variable functional impairment.

Clinical implications. The present study has significant implications for the treatment of children with ADHD. Results of this study indicate that overall functional impairment and FIV in children with ADHD are related to frequent and intense variability in affect. Although research has supported the effectiveness of stimulant medications and behavioral parent training for the treatment of ADHD (Pelham, Wheeler, & Chronis, 1998), these approaches do not focus on the emotional impulsivity component of functional impairment in this population (Waxmonsky et al., 2013). The present study suggests that to lessen the severity and variability of functional impairment in children with ADHD, emotion dysregulation must be addressed. Thus, treatment for ADHD would likely be most beneficial to children if it focused on developing and improving skills, such as emotion regulation, frustration management, and problem solving. This could potentially help children better manage intense negative emotionality and prevent their emotions from negatively impacting other areas of functioning. In addition, teaching parents to better recognize the emotional triggers of their children could help make children's behavior more predictable to parents and enable them to deescalate the situation and minimize the more intense negative emotional reactions displayed by their children. Currently, there are no treatments for children with ADHD that specifically address the emotional difficulties of this population (Waxmonsky et al., 2013).

The findings of the present study accentuate the importance of developing interventions for children with ADHD that address emotional impulsivity and regulation in addition to addressing the attentional and behavioral symptoms typically associated with ADHD. Numerous studies have implicated emotion dysregulation as a key factor in the functional impairment (Anastopoulos et al., 2011), emotional and behavioral difficulties (Anastopoulos et al., 2011; Rosen et al., n.d.), social difficulties (Melnick & Hinshaw, 2000), and parental–child difficulties experienced by children with ADHD (Graziano et al., 2013). In fact, studies have found that children with ADHD who demonstrate improved emotional and behavioral functioning in response to psychosocial treatment also demonstrate related changes in neurological regions associated with emotion regulation (Lewis et al., 2008).

The current study focused exclusively on a specific domain of emotion dysregulation, emotional impulsivity, which appears to play a substantial role in functional impairment and other difficulties in children with ADHD. Essentially, the emotional state of the child appears to be concordantly related to how well a child behaves, interacts with others, performs on tasks, and views himself or herself, which ultimately impacts others' perceptions of the child's functional impairment in specific domains. Of note, emotional impulsivity was only related to overall functional impairment and FIV among children in the context of ADHD. It is therefore principally important that interventions focus on assisting children with ADHD in recognizing and coping with their emotional impulsivity so that they can reduce the frequency and intensity of their emotional reactions.

Limitations

This study provided encouraging support for the association of EMA-derived emotional impulsivity with overall functional impairment and FIV among children with but not children without ADHD. However, several limitations must be taken into account. This study represented an initial examination of the relation of emotional impulsivity with overall functional impairment and FIV in children with and without ADHD. Although this study demonstrated a strong interaction of emotional impulsivity and ADHD to overall functional impairment and FIV, all data in this study were obtained simultaneously. It is therefore not possible to determine the direction of the effects found in this study. Further studies are needed to illustrate the longitudinal direction of this relation to determine if emotional impulsivity is a cause or result of greater functional impairment and/or FIV in children with ADHD. In addition, this study found differential relations of emotional impulsivity to

functional impairment in children with and without ADHD; however, it is notable that children without ADHD demonstrated minimal functional impairment in the present study. This is consistent with previous research demonstrating that functional impairment is not commonly seen in typically functioning children (Fabiano et al., 2006). Due to the children without ADHD having consistently minimal functional impairment, it was difficult to assess if emotional impulsivity was associated with overall or variable functional impairment in this group. Finally, the small sample in the study may have reduced the power of the analyses to detect small but meaningful effects and examine within-group differences in the ADHD sample. For instance, the small sample size may partially explain why the means of the ADHD and non-ADHD groups did not significantly differ on the measure of emotional impulsivity. Alternatively, it is possible that all children have the potential to demonstrate emotional fluctuations throughout the day despite whether or not they meet criteria for ADHD. Regardless of the small sample size, the analyses were able to reveal substantial relations of emotional impulsivity to overall functional impairment and FIV among children with ADHD and a significant interaction of ADHD and emotional impulsivity. Nevertheless, further longitudinal studies need to be conducted with larger sample sizes to determine the strength of the findings and the directions of the effects across multiple samples.

EMA presents several additional limitations. EMA-based ratings allow for multiple assessments of mood but do not provide information about context at the time of each of the ratings. Therefore, it was not possible to determine why a child's ratings were elevated or reduced at any time point. Similarly, the parents' emotional state while completing ratings was not measured. This is particularly relevant given that there is a substantial body of research suggesting that parents of children with ADHD experience significantly greater stress (Theule, Wiener, Tannock, & Jenkins, 2013) and that parenting stress can substantially impact parent ratings of children's mood (Gartstein, Bridgett, Dishion, & Kaufman, 2009). However, it is important to note that in the present study, there were no significant differences between children with and without ADHD on the EMA-derived ratings of emotional impulsivity. In addition, the study was unable to collect EMA data during the school day. As school is often an area of substantial difficulty for children with ADHD, the procedures of this study may have underestimated emotional impulsivity among children with ADHD. However, given that the statistic used in this study to determine emotional impulsivity and FIV (MSSD) can be artificially inflated when there is environmental or reporter inconsistency between consecutive intervals, the present findings may best be interpreted as an accurate representation of the child's emotional impulsivity within the home environment. Similarly, this study relied on a single (parent) rater for the EMA-derived measure of emotional impulsivity, Total FI, and FIV due to previous research suggesting that child EMA ratings of emotional impulsivity are unreliable (Rosen et al., 2013; Rosen & Factor, 2012); however, it is possible that the ratings of emotional impulsivity and functional impairment were skewed according to parent characteristics and perceptions. In addition, MSSD aggregates EMA data within each subject across the 28-day assessment period, which limited the determination of how within-day-emotional variation predicted functional impairment for that day. Finally, this study relied on a predictable rather than a random schedule of assessment intervals. Although it was necessary to permit parents to dictate the schedule of alerts to ensure that they would be able to actively observe their children while completing ratings, it is possible that this predictable schedule influenced the results by attenuating parent or child behavior in anticipation of the assessment intervals. This may have decreased variability between consecutive rating intervals.

Conclusion

The current study represents an important step toward understanding the powerful relation of temporal emotional impulsivity to the overall functional impairment and FIV of children with ADHD. Emotional impulsivity appears to uniquely impact the functional impairment of children with ADHD, as their inability to recognize, regulate, and control their frequent and intense emotional reactions inhibits their ability to behave, interact, and perform appropriately or at their actual ability level. This results in these children experiencing more severe and variable functional impairment, as the degree to which they are impaired is often concordantly related to their emotional state in that moment. The fact that this pattern appears to be specifically related to ADHD suggests that it is the interaction of emotional impulsivity with the pattern of impulsivity and dysregulation characteristic of children with ADHD that produces greater levels of overall functional impairment and greater degrees of variability in functional impairment. Our hope is that by improving our understanding of how emotional impulsivity impacts children with ADHD, we can more successfully assess and treat this difficulty and improve and stabilize the overall functioning of children with ADHD.

Declaration of Conflicting Interests

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