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Emotional Impulsivity and Emotional and Behavioral Difficulties Among Children With ADHD: An Ecological Momentary Assessment Study

Paul J. Rosen[1] and Perry I. Factor[1]

Abstract

Objective: Children with ADHD often demonstrate impulsive shifts in emotion, characterized by sudden and intense shifts in affect. This study examined the effects of emotional impulsivity over time on the emotional and behavioral functioning of children with ADHD using ecological momentary assessment (EMA). **Method:** Twenty-seven 8- to 12-year-old children with ADHD, and their parents, completed baseline measures of the children's emotional and behavioral functioning. Parents and children then completed an EMA protocol, whereby they each rated the child's affect three times daily for 28 days. **Results:** Hierarchical regression analyses strongly supported the relation of greater EMA-derived emotional impulsivity to children's increased emotional and behavioral difficulties. These effects were evident across reporters and were maintained after controlling for baseline emotion dysregulation. **Conclusion:** Overall, this study demonstrated the utility of EMA-based assessments and suggested that emotional impulsivity may play an important role in the emotional and behavioral functioning of children with ADHD. *(J. of Att. Dis. 2015; 19(9) 779-793)*

Keywords

ecological momentary assessment, ADHD, emotional impulsivity, emotion regulation, emotional reactivity

Introduction

Comorbid emotional and behavioral difficulties have long been among the most robust findings among children with ADHD dating back to the earliest formulations of the disorder (Barkley, 2010). Although emotional and behavioral difficulties are not currently encapsulated by the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000) criteria, studies have repeatedly demonstrated substantially elevated levels of emotional and behavioral distress in children with ADHD (Strine et al., 2006). Emotional impulsivity has been proposed as a mechanism linking ADHD to emotional and behavioral distress (Barkley, 2010).

Emotional Impulsivity and ADHD

Emotional difficulties have been identified as a "core component" of ADHD (Barkley, 2010). Children with ADHD are more apt to experience emotional distress and negative emotions than children without ADHD (Strine et al., 2006), to have more intense emotions (Barkley, 2010), and to have difficulty inhibiting and controlling their negative emotional reactions to distressing or frustrating situations (Walcott & Landau, 2004). Barkley (2010) noted that children with ADHD often experience highly variable emotions and intense and sudden shifts in emotion, such that their emotional reactions are often more automatic and of significantly greater intensity than those of typically functioning children. Barkley (2010) and others have used the term *emotional impulsivity* to describe this pattern of variable and intense emotional reactivity. Although emotional difficulties are most commonly examined in relation to negative emotions, Jensen and Rosen (2004) indicated that children with ADHD have more intense reaction to positive *and* negative stimuli than do children without ADHD. Similarly, children with ADHD frequently switch between positive and negative emotional states, as studies indicate that children with ADHD are more emotionally labile than children without ADHD (Anastopolous et al., 2011; Sobanski et al.,

[1]University of Louisville, KY, USA

Corresponding Author:
Paul J. Rosen, Department of Psychological and Brain Sciences, University of Louisville, 353 Life Sciences, Louisville, KY, 40292, USA.
Email: Paul.Rosen@louisville.edu

2010) and their emotional shifts are of greater intensity (Norvilitis, Casey, Brooklier, & Bonello, 2000).

Emotional impulsivity varies considerably within children with ADHD. Indeed, evidence has increasingly suggested that a subgroup of significantly emotionally impulsive children may exist within the diagnosis of ADHD. Anastopolous and colleagues (2011) noted that approximately 35% to 50% of clinic-referred children with ADHD evidenced emotional lability, and that emotional lability partially mediated the association of ADHD with emotional and behavioral difficulties. Studies have suggested that emotional impulsivity may be most prevalent within the ADHD-Combined Type subtype (Maedgen & Carlson, 2000; Martel, 2009), although Barkley (2010) summarized research indicating that emotional impulsivity may also be common among children within the ADHD-Inattentive subtype who demonstrate a subthreshold level of hyperactive/impulsive symptoms (as opposed to children with a "sluggish cognitive tempo" presentation of ADHD-Inattentive type). Emotional impulsivity is linked to multiple forms of impairment among children with ADHD, including oppositional behavior (Sobanski et al., 2010), emotional difficulties, functional impairment (Anastopolous et al., 2011), social difficulties, and aggression (Melnick & Hinshaw, 2000). Anastopolous and colleagues found that emotional lability partially mediated the association of ADHD with emotional and behavioral difficulties, whereas others have speculated that emotional impulsivity and dysregulation may account for the substantial rates of comorbid behavior, mood, and anxiety disorders among children with ADHD (Barkley, 2010; Martel, 2009; Skirrow, McLoughlin, Kuntsi, & Asherson, 2009).

Ecological Momentary Assessment (EMA) of Emotional Impulsivity in ADHD

Emotional variability in children has most commonly been measured through use of retrospective report instruments or laboratory-based assessments (Porges, Doussard-Roosevelt, & Maiti, 1994; Shields & Cicchetti, 1997). Retrospective report instruments and physiological assessment provide considerable information regarding emotion dysregulation, but neither method is able to fully capture the dynamic temporal structure of children's emotional experience. Retrospective report rating scales typically collapse across time points, which does not allow for ecologically valid assessment of differential patterns of emotional impulsivity across time (Ebner-Priemer & Trull, 2009). Although retrospective report measures do exist that seek to assess emotional impulsivity and lability (Sobanski et al., 2010), such measures rely on parents or children to *estimate* the child's patterns of emotional variability rather than directly assessing variability through repeated assessment. Retrospective report is also subject to a host of cognitive biases, including recency effects, emotional salience, summing across events, and recall deficiencies (Piasecki, Hufford, Solhan, & Trull, 2007). Physiological assessment is similarly limited in assessing emotional lability and impulsivity. Physiological assessment methodologies provide valuable objective snapshots of emotional arousal in response to single or repeated laboratory-based experimental stimuli (Hessler & Katz, 2007; Porges et al., 1994) but do not allow for a high-frequency repeated assessment of emotions in an ecologically valid setting (i.e., real-world setting).

By contrast, EMA methodologies hold substantial promise for the assessment of emotional impulsivity in children. EMA describes methodologies developed to collect real-time data from participants within the context of their typical daily lives (Stone & Shiffman, 1994). EMA provides substantially more accurate response data than retrospective or summary report, even when compared with end-of-day recall (Stone & Shiffman, 1994). Ebner-Priemer and Trull (2009) note that accurate assessment of patterns of emotional variability (such as emotional impulsivity) requires methodologies that account for amplitude, variability, and temporal dependency. By allowing for repeated assessment over time, EMA methodologies allow the researcher to "map out" the variability of an individual's emotional state to account for frequency and intensity of emotional shifts (Ebner-Priemer & Trull, 2009). EMA has demonstrated tremendous promise in assessing affective variability in normal adult populations and adults with clinical disorders linked to affective variability (Jahng, Wood, & Trull, 2008; Miller, Vachon, & Lynam, 2009), and is more accurate than and only modestly associated with retrospective recall (Solhan, Trull, Jahng, & Wood, 2009). EMA has shown similar validity as an assessment methodology in child populations, including studies of affective variability in children (Suveg, Payne, Thomassin, & Jacob, 2010) and anger in children with ADHD (Whalen et al., 2009). A pilot study conducted by the lead author demonstrated the feasibility of EMA to assess mood in children with ADHD and emotional difficulties (Rosen & Epstein, 2010). EMA thus represents a uniquely suitable methodology to assess emotional impulsivity in children with ADHD.

Research Questions

Given the evidence of the role that emotional impulsivity may play in the emotional and behavioral impairment often demonstrated by children with ADHD (Anastopolous et al., 2011; Barkley, 2010), we sought to examine the effects of EMA-assessed emotional impulsivity on the emotional and behavioral functioning of children with ADHD. We hypothesize that EMA will represent a feasible means of assessing parent- and child-report emotional impulsivity. We further hypothesize that EMA-derived emotional impulsivity will be related to emotional and behavioral difficulties in children

with ADHD above and beyond the influence of total affect (TA) and global emotion dysregulation difficulties.

Method

Participants

Twenty-seven children (19 boys, 8 girls) ages 8 to 11 years (M = 9.29, SD = 1.07) and their families participated in the present study. Families were recruited for participation through advertisements distributed through local schools in a midsized Midwestern metropolitan area. To ensure consistency across the EMA protocol, children were only eligible for participation if they were resident in a single home (i.e., two-parent or single-parent family) full-time over the course of the study. 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 subthreshold level of hyperactive/impulsive symptoms, but is not present within 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 3 hyperactive/impulsive symptoms. The Diagnostic Structured Interview for Children (DISC; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000) was used to assess ADHD status. All children in the study met full criteria for ADHD (Combined Type = 17, Inattentive Type = 10), whereas 16 also met criteria for at least one comorbid behavioral, mood, or anxiety (excluding specific phobia) diagnosis. Fourteen of the 27 children were receiving medication treatment for ADHD concurrent to participation, with 10 receiving stimulant medication, 3 receiving nonstimulant medication, and 1 receiving stimulant and nonstimulant medications for ADHD. Medication status and dose remained consistent throughout the study for all participants. The ethnic composition of the sample was reflective of the area from which the population was drawn (U.S. Census Bureau, 2010) with 59.3% of the children described as non-Hispanic White/Caucasian, 33.3% of the children described as non-Hispanic Black/African American, and 7.4% of the sample described as Hispanic/Latino.

Procedures

Baseline session. Parents of children provided informed consent and children provided assent prior to the initiation of any study procedures. During a baseline session, parents completed a structured diagnostic interview to determine whether their child met criteria for ADHD. Parents and children also completed questionnaires regarding the child's internalizing behavior, externalizing behavior, and emotion regulation at the time of the baseline assessment. Parents and children received training in completion of the EMA protocol. Parents and children each received compensation for completing the baseline session, with parents receiving US$15 and children receiving a US$25 gift card.

EMA protocol. Parents and children completed EMA-based ratings three times daily for a period of 28 days (84 total time points). The 28-day assessment period was selected over the shorter (i.e., 1 week) periods utilized in previous studies (i.e., Suveg et al., 2010; Whalen et al., 2009) to ensure that assessments captured a full temporal range of emotional variation. All ratings were completed using Palm® Tungsten E2 Personalized Data Assistants (PDA) that had been programmed using Purdue Momentary Assessment Tool software (PMAT; Weiss, Beal, Lucy, & MacDermid, 2004). 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. Parents and children were asked to complete ratings at all time points.

Parents were instructed that one parent was to be responsible for completing all EMA intervals to allow for assessment of within-informant variability, and that the parent EMA ratings were to be completed by the same individual as the baseline ratings. Parents indicated their identity (i.e., mother, father, guardian) prior to completing ratings at each time. Parent ratings were completed prior to child ratings at each time point, and children had the option of refusing to complete ratings. At each time point, parents were asked to complete the Positive and Negative Affect Scale–Parent Report (PANAS-PR; Phillips, Lonigan, Driscoll, & Hooe, 2002) regarding their perception of their child's positive affect (PA) and negative affect (NA) *at the specific time of the assessment*. Similarly, children were asked to complete the PANAS-Child Report (PANAS-C; Laurent et al., 1999) regarding their self-perceived PA and NA *at the specific time of the assessment*. To minimize the disruption to participants' daily lives and enhance adherence to the EMA protocol, 10-item versions of the PANAS-PR and PANAS-C were created using the items from Thompson's (2007) PANAS–Short Form using the same 10 items for the parent- and child-report PANAS. Given the young age of the children in the study and the impulsivity and disorganization that is often inherent in children with ADHD, parents were asked to be responsible for the PDA at all times that they were not present with their child. This prohibited any data collection during the school day, thus all assessment time points reflect times that occur outside of school hours.

To enhance participant adherence to the EMA protocol, parents were provided with compensation that was commensurate with their completion of EMA ratings. Specifically, each week, parents could receive up to US$10 (US$40 total over the 4 weeks) based on the percentage of completed rating intervals. Children were not compensated for completing the EMA protocol, and children's noncompletion of EMA ratings was not reflected in parent

compensation. All procedures within this study were approved by the local Institutional Review Board.

Measures

Measures of overall emotional and behavioral difficulties. The *DISC–Version IV, Parent Report* (DISC-P; Shaffer et al., 2000) was used to provide diagnostic assessment of children in the study. The DISC-P is a diagnostic structured interview that provides a reliable means of assessing for the presence of psychological disorders in children. The DISC-P has demonstrated reliability and validity in a broad array of settings (Shaffer et al., 2000).

The Child Behavior Checklist (CBCL; Achenbach, 2001) was used to assess parent's perceptions of internalizing/externalizing behaviors in children. The CBCL is a 113-item parent-report measure of children's emotional and behavioral problems, yielding two composites (internalizing problems and externalizing problems). The CBCL provides *T*-scores that are normed by age and gender (Achenbach, 2001). The CBCL-Internalizing and -Externalizing scales were used in the current study as an index of the parent's perceptions of their child's affective and behavioral difficulties, respectively. The CBCL-Internalizing and -Externalizing scales demonstrated excellent internal consistency in this study (αs = .91-.92).

The Children's Depression Inventory–Short Form (CDI-S; Kovacs, 1992) was used to assess children's perceptions of their affective functioning. The CDI-S is a 10-item child-report measure that assesses the presence of depressive symptoms in children. The CDI-S has been clinically normed and provides *T*-scores that are normed by age and gender (Kovacs, 1992). The CDI-S is a brief version of the 27-item self-report inventory and is substantially correlated with the long-form CDI (Kovacs, 1992). The CDI-S was used in the current study as an index of children's perceptions of their own affective difficulties. The CDI-S demonstrated excellent internal consistency in the current study (α = .82).

The Proactive Aggression subscale of the Reactive-Proactive Aggression Questionnaire (RPAQ-Proactive); Raine et al., 2006) was used to assess children's perceptions of their aggressive behavior. The RPAQ is a 23-item self-report measure that assesses the frequency of aggressive, reactive, and destructive behavior in children. Research has suggested that reactive and proactive aggression are independent constructs, with proactive aggression linked with deviant behavior. The Proactive Aggression subscale was used in this study to assess instrumentally aggressive behavior and demonstrated excellent internal consistency (α = .89).

The Emotion Regulation Checklist (ERC; Shields & Cicchetti, 1997) was used to assess parent's perceptions of their children's overall emotion dysregulation. The ERC is a 24-item parent report that assesses negative emotionality and emotionally dysregulated behaviors in children (Shields & Cicchetti, 1997). The ERC is widely used as a broad-spectrum measure of emotionally dysregulated behavior (Shields & Cicchetti, 1997). The ERC was used in the current study to control for parent's perceptions of their child's overall emotion dysregulation. The ERC demonstrated excellent internal consistency in the current study (α = .90).

EMA Measures of Emotional Impulsivity

The PANAS (Watson, Clark, & Tellegen, 1988) was used to assess TA and affect variability in children. The PANAS was administered to parents and children three times daily for 28 days as part of the EMA protocol. At each time point, parents and children filled out a PANAS-PR (Phillips et al., 2002) and PANAS-C (Laurent et al., 1999), respectively. The PANAS-PR is a 20-item adaptation of the PANAS designed to assess parent's perceptions of their children's PA, NA, and TA. The 10-item PANAS-PR was created for this study using the items from the adult self-report 10-item PANAS–Short Form. The 10-item PANAS-C was created for this study by adapting the PANAS-10 item (Thompson, 2007) using the analog terms from the 20-item PANAS-C (Laurent et al., 1999). Studies have indicated that the 10-item PANAS is psychometrically analogous with the full version (Thompson, 2007). The PANAS has previously demonstrated utility in studies utilizing an EMA methodology (Shrier, Shih, & Beardslee, 2005). Prior to creating EMA variables, each EMA time point was examined to ensure that it had been completed by the primary rater in the presence of the child. Parent-report time points were removed from the data set if (a) they were not completed by the primary rater or (b) the parent indicated that the child was asleep or not physically present.

For the current study, we created NA, PA, and TA scores for the PANAS-PR and PANAS-C at each EMA interval by summing all responses from that particular EMA interval to the PANAS-PR and PANAS-C, respectively. Mean NA, PA, and TA scores were created by averaging the scores from the PANAS-PR and PANAS-C across each interval to represent the child's average total affective intensity across all intervals. Mean squared successive difference (MSSD) scores were created from the PANAS-PR and PANAS-C to represent the variability and temporal instability of the child's affect across all intervals. Procedures were performed separately for the PANAS-PR and PANAS-C to create separate indices of parent-reported and child self-perceived affect. MSSD scores were created using the procedures recommended by Solhan and colleagues (2009). Scores were created by (a) taking the difference of each successive within-day rating point (i.e., morning-afternoon and afternoon-evening), (b) squaring each of the successive within-day difference scores, and (c) averaging the within-day MSSDs across all 28 days of the study. This procedure

creates a single score that accounts for the frequency and amplitude of within-day variability over a 28-day period. MSSD scores have demonstrated reliability and validity as a means of assessing variability within EMA data series (Jahng et al., 2008), as they account for the frequency, amplitude, and temporal dependency of change within an EMA data series (Miller et al., 2009). MSSD scores are also robust to systematic time trends and do not require that time series data be detrended prior to analysis. Separate MSSD scores were created from the PANAS-PR and PANAS-C to assess parent- and child report of the variability and intensity of children's NA, PA, and TA. Examination of the data indicated significant skew in the child-report PANAS NA mean (skew = 2.38) and the child-report NA (skew = 2.02), PA (skew = 1.23), and TA (skew = 1.83) MSSD scores, thus these variables were log transformed prior to being entered into all analyses.

Statistical Methods and Model Selection

Analyses were conducted to examine each of the hypotheses. To examine feasibility and adherence to the EMA protocol (Hypothesis 1), descriptive analyses were conducted to examine the parents' and children's rates of completion of EMA intervals and concordance between parent and child report. Exploratory bivariate correlation and hierarchical linear regression analyses were conducted to examine the relation of EMA-derived emotional impulsivity to internalizing and externalizing difficulties in children (Hypothesis 2). Age, gender, ADHD subtype, and medication status were included as covariates in all hierarchical regression analyses, as each has well-established effects on rates of internalizing and externalizing difficulties in children. ERC score was also entered as a covariate in all hierarchical regression analyses to control for overall emotionally dysregulated behavior and establish the relation of emotional impulsivity to internalizing and externalizing difficulties in children above and beyond the effects of overall emotionally dysregulated behavior. Similarly, EMA-derived mean TA was entered into all hierarchical regression analyses prior to EMA-derived emotional impulsivity so as to partial out the effects of overall TA from the relation of emotional impulsivity to internalizing and externalizing difficulties in children. All analyses were conducted with IBM® SPSS®, Version 20. Of note, the small sample size in the current study suggests that all analyses should be considered exploratory rather than confirmatory. Due to the small sample size, analyses in the present study were only substantially powered enough to detect moderate to large effects. Therefore, the absence of a demonstrated effect in the current analyses may reflect an inability of the analyses to detect a small but robust effect rather than the absence of such an effect.

Results

Feasibility and adherence to the EMA protocol. Overall, parents and children demonstrated excellent adherence to the EMA protocol. Adherence statistics were calculated *after* the removal of rating points that violated the study procedures (i.e., completed by person other than the primary rater, completed while child was asleep or not physically present). Parents completed a total of 1,931 rating points (M = 71.52, SD = 7.30) and children completed a total of 1,757 rating points (M = 65.07, SD = 12.71). All 27 parents completed at least 65% of all rating intervals (M = 85%, SD = 0.09, minimum = 65%), whereas 22 of 27 children completed at least 65% of all rating intervals (M = 77%, SD = .15, minimum = 46%). Of note, parents rated children as demonstrating substantially more NA during intervals where their child did not complete rating intervals (M = 6.32, SD = 2.42) than during intervals where their child did complete rating intervals, M = 5.95, SD = 1.84; $t(1,928)$ = 2.66, $p < .01$. No differences were evident in parents' ratings of their children's PA, $t(1,928) = 1.36$, $p > .15$, or TA, $t(1,928) = 0.72$, $p > .50$, between intervals where the child did and did not complete ratings.

Concordance between parent and child ratings. Correlation coefficients were computed for each individual series of EMA ratings of PANAS NA, PA, and TA to examine the relation of parent and child perception of the child's affect. Parent and child EMA ratings demonstrated a broad range of correlation coefficients across participants on the PANAS NA (−.04 to .95), PANAS PA (−.49 to .72), and TA (−.54 to .84). Parents and children demonstrated some concordance in their ratings of the child's NA (16 of 27, rs > .20, Mr = 0.34, SD = 0.26), but minimal concordance in their ratings of the child's PA (12 of 27, rs > .20, Mr = 0.20, SD = 0.23) and TA (10 of 27, rs > .20, Mr = 0.19, SD = 0.25). However, minimal concordance was demonstrated across all three indices for squared successive difference scores, with few participants demonstrating rs < .20 across NA (11 of 27, Mr = .27, SD = 0.35), PA (5 of 27, Mr = .01, SD = 0.25) and TA (4 of 27, M = 0.05, SD = 0.28). Given these findings, it was not surprising that there was also minimal correlation between parents and children regarding the overall PANAS NA MSSD, PA MSSD, or TA MSSD, rs(27) = −.02 to .28, ps > .15. Overall, results suggested little concordance between parents and children regarding the child's overall affect or change in affect from one interval to the next.

Relation of EMA-derived emotional impulsivity to internalizing and externalizing difficulties. Initial bivariate analyses (see Table 1) were conducted to assess the relation of the EMA-derived measures of parent- and child-reported emotional impulsivity (i.e., parent- and child-report PANAS TA MSSD) to the parent- and child-report measures of internalizing difficulties (CBCL-Internalizing and CDI, respectively) and externalizing difficulties (CBCL-Externalizing

Table 1. Bivariate Correlations of Emotional Impulsivity, Emotional Difficulties, and Behavioral Difficulties (N = 27).

Measure	1	2	3	4	5	6	7
EMA-derived measures							
1. Parent-report mean TA	—						
2. Parent-report TA MSSD (emotional impulsivity)	−.10	—					
3. Child-report mean TA	.39**	−.03	—				
4. Child-report TA MSSD (emotional impulsivity)	−.31	.37*	−.04	—			
Retrospective report measures							
5. CBCL-Internalizing	−.12	.54***	−.02	.08	—		
6. CDI-Total	−.30	.41**	.10	.24	.17	—	
7. CBCL-Externalizing	−.38**	.38**	−.04	−.03	.47***	.38**	—
8. RPAQ-Proactive Aggression	−.03	.62****	.05	.29	.28	.55***	.18

Note. EMA = ecological momentary assessment; TA = total affect; MSSD = mean squared successive difference; CBCL = Child Behavior Checklist; CDI = Children's Depression Inventory; RPAQ = Reactive-Proactive Aggression Questionnaire–Proactive.
*p < .10. **p < .05. ***p < .01. ****p < .001.

and RPAQ-Proactive Aggression, respectively). Moderate to large positive correlations were observed between parent-reported emotional impulsivity and parent-reported measures of internalizing problems, $r(27) = .54$, $p < .005$, and externalizing problems, $r(27) = .38$, $p = .05$, suggesting that greater parent-reported emotional impulsivity was related to more parent-reported emotional and behavioral difficulties. Moderate to large positive correlations were also observed between parent-reported emotional impulsivity and child-reported measures of internalizing problems, $r(27) = .41$, $p < .05$, and instrumental aggression, $r(27) = .62$, $p < .001$, suggesting that greater parent-reported emotional impulsivity was also related to more child-reported emotional and behavioral difficulties. These results were particularly encouraging, as they provided multiple-source evidence of a link between parent-reported emotional impulsivity and emotional and behavior problems in children. Surprisingly, analyses revealed minimal relations of child-reported emotional impulsivity with either parent-reported emotional and behavioral problems, rs(27) = −.03 to .04 ps > .50, or child-reported emotional and behavioral problems, rs(27) = .24 to .29, ps > .10. Overall, bivariate analyses supported the validity of parent-reported EMA-derived emotional impulsivity scores with regard to emotional and behavioral difficulties in children but did not support the validity of the child-report EMA-derived emotional impulsivity scores. Accordingly, child-report EMA-derived emotional impulsivity scores were dropped from future analyses.

Multivariate hierarchical linear regression analyses were conducted to examine the impact of parent-reported EMA-derived emotional impulsivity on children's internalizing and externalizing problems. Each of the indicators of internalizing and externalizing problems (CBCL-Internalizing, CBCL-Externalizing, CDI, and RPAQ-Proactive Aggression) was regressed on the EMA-derived indicator of emotional impulsivity (parent-reported PANAS TA MSSD). Several variables were entered into the first step to control for factors that are known to be linked to higher rates of internalizing and/or externalizing problems in children with ADHD, including age, gender, ADHD subtype, and medication status. ERC score was also entered into the first step to control for the child's overall emotionally dysregulated behavior and demonstrate the incremental validity of EMA-based measures of emotional impulsivity over retrospective report questionnaires in predicting children's emotional and behavioral difficulties. PANAS mean TA scores were entered into the second step to control for differences in children's overall affect and allow for emotional impulsivity to be examined separately from overall affect. Finally, PANAS TA MSSD scores were entered into the third step to assess the impact of emotional impulsivity on children's emotional and behavioral difficulties. Akaike Information Criteria (AIC) was used to assess model fit, with ΔAIC representing the difference between the AIC with the inclusion of PANAS TA MSSD and the next best fitting model. Negative ΔAIC scores indicated lower AIC and thus improved fit for the inclusion of PANAS TA MSSD in the overall model.

Relation of emotional impulsivity to internalizing difficulties

Results strongly supported the hypothesis that parent-reported emotional impulsivity was related to the emotional difficulties of children with ADHD (see Tables 2 and 3, and Figure 1), as results suggested the model fit was substantially improved by inclusion of parent-reported PANAS TA MSSD in the estimation of CBCL-Internalizing, $\Delta R^2 = .16$, $p < .05$, AIC = 102.17, ΔAIC = −2.87 and CDI scores, $\Delta R^2 = .17$, $p < .05$, AIC = 137.71, ΔAIC = −6.08. Results

Table 2. Hierarchical Regression Estimating Parent-Reported Internalizing Difficulties (CBCL-Internalizing Scale; *N* = 27).

Step/variable	R^2	ΔR^2	AIC	*B*	*SE B*	*t*	β
Step 1	.30	.30	123.02				
Gender (male = 0, female = 1)				−5.24	4.48	−1.17	−.26
Age				−0.25	1.81	−0.14	−.03
ADHD subtype (inattentive = 0, combined = 1)				−3.50	4.40	−0.80	−.18
Medication status (no medication = 0, medication = 1)				0.11	4.18	0.03	.01
ERC total (overall emotion regulation)				13.12	6.00	2.20	.50**
Step 2	.30	.00	124.99				
EMA parent-report mean TA				0.10	0.58	0.17	.03
Step 3	.46	.16**	120.17				
Parent-report TA MSSD (emotional impulsivity)				0.30	0.13	2.34	.43**

Note. CBCL = Child Behavior Checklist; AIC = Akaike Information Criteria; ERC = Emotion Regulation Checklist; TA = total affect; EMA = ecological momentary assessment; MSSD = mean squared successive difference.
*p < .10. **p < .05. ***p < .01. ****p < .001.

Table 3. Hierarchical Regression Estimating Child-Reported Internalizing Difficulties (CDI-10; *N* = 27).

Step/variable	R^2	ΔR^2	AIC	*B*	*SE B*	*t*	β
Step 1	.23	.23	146.15				
Gender (male = 0, female = 1)				9.72	6.88	1.41	.33
Age				−0.71	2.71	−0.26	−.05
ADHD subtype (inattentive = 0, combined = 1)				9.29	6.74	1.38	.33
Medication status (no medication = 0, medication = 1)				5.06	6.41	0.79	.19
ERC total (overall emotion regulation)				6.29	9.15	0.69	.16
Step 2	.34	.14*	143.79				
EMA parent-report mean TA				−1.55	0.83	−1.87	−.37*
Step 3	.51	.17**	137.71				
Parent-report TA MSSD (emotional impulsivity)				0.46	0.18	2.57	.45**

Note. CDI = Children's Depression Inventory; AIC = Akaike Information Criteria; ERC = Emotion Regulation Checklist; EMA = ecological momentary assessment; TA = total affect; MSSD = mean squared successive difference.
*p < .10. **p < .05. ***p < .01. ****p < .001.

indicated that PANAS TA MSSD scores were positively associated with emotional difficulties given the current set of variables, such that children with greater PANAS TA MSSD scores also had higher CBCL-Internalizing, β = .43, t = 2.34, 95% confidence interval (CI) = [0.03, 0.58], p < .05, and CDI scores, β = .45, t = 2.57, 95% CI = [0.09, 0.84], p < .05. Results indicated that the covariates entered into the first step did not sufficiently explain the CBCL-Internalizing scores, ΔR^2 = .30, p > .15, AIC = 123.03 or CDI scores, ΔR^2 = .23, p > .30, AIC = 146.15. Examination of the individual covariates indicated that greater parent-report internalizing difficulties were observed among children with greater overall emotionally dysregulated behavior, β = .50, t = 2.20, 95% CI = [0.72, 25.53], p < .05, but that no covariates were associated with greater child-reported internalizing difficulties in the current model. PANAS mean TA did not substantially improve the fit of the current model to the estimation of parent-report (ΔR^2 = .03, p > .85, AIC = 124.99) internalizing difficulties and marginally improved the fit of the current model to the estimation of child-report internalizing difficulties, ΔR^2 = .11, p = .08, AIC = 143.79, β = −.37, t = −1.87, 95% CI = [−3.27, 0.18]. The overall model was modestly well fit to parent-reported internalizing difficulties, R^2 = .46, F(7, 19) = 2.29, p = .07, and child-reported internalizing difficulties, R^2 = .51, F(7, 19) = 2.84, p > .05. Overall, results suggested that children

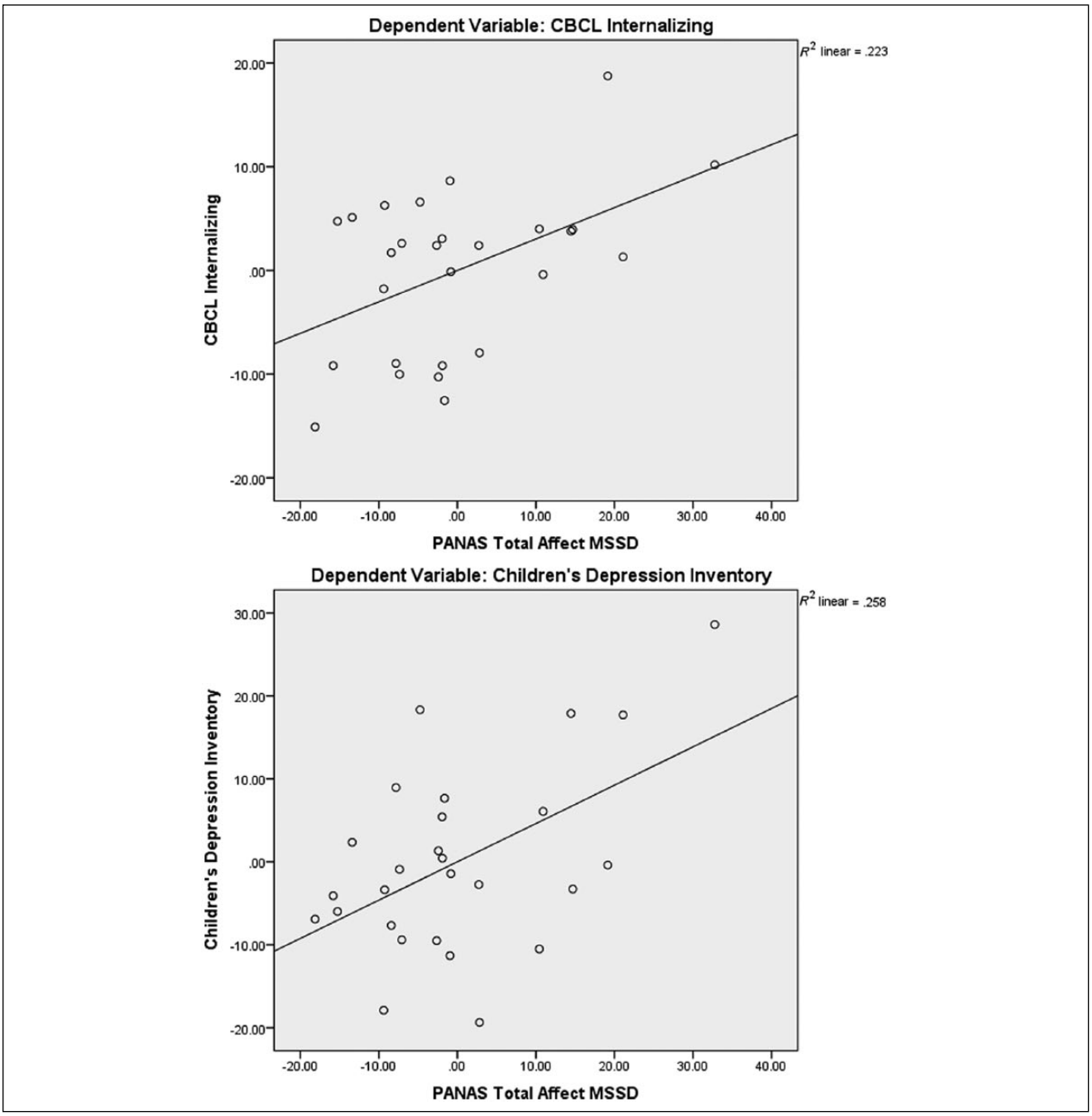

Figure 1. Scatterplots of partial correlation of emotional impulsivity (PANAS TA MSSD) and internalizing difficulties (CBCL-Internalizing, CDI).
Note. PANAS = Positive and Negative Affect Scale; TA = total affect; MSSD = Mean squared successive difference; CBCL = Child Behavior Checklist; CDI = Children's Depression Inventory.

whose parents rated them as demonstrating more emotional impulsivity over the 4-week EMA period were experiencing substantially more parent-reported and self-reported emotional difficulties. Encouragingly, this effect was evident in within-rater and across-rater analyses, as parent-reported emotional impulsivity across the EMA protocol was related to parent- and child-reported internalizing difficulties on retrospective recall questionnaires.

Table 4. Hierarchical Regression Estimating Parent-Reported Externalizing Difficulties (CBCL-Externalizing Scale; *N* = 27).

Step/variable	R^2	ΔR^2	AIC	*B*	*SE B*	*t*	β
Step 1	.51	.51***	117.80				
Gender (male = 0, female = 1)				−3.76	4.07	−0.92	−.17
Age				2.37	1.60	1.48	.25
ADHD subtype (inattentive = 0, combined = 1)				5.25	4.00	1.32	.25
Medication status (no medication = 0, medication = 1)				2.82	3.79	0.74	.14
ERC total (overall emotion regulation)				9.62	5.42	1.77	.34*
Step 2	.63	.13**	111.78				
EMA parent-report mean TA				−1.20	0.46	−2.63	−.39**
Step 3	.71	.07**	107.83				
Parent-report TA MSSD (emotional impulsivity)				0.22	0.10	2.16	.29**

Note. CBCL = Child Behavior Checklist; AIC = Akaike Information Criteria; ERC = Emotion Regulation Checklist; EMA = ecological momentary assessment; TA = total affect; MSSD = mean squared successive difference.
*p < .10. **p < .05. ***p < .01. ****p < .001.

Table 5. Hierarchical Regression Estimating Child-Reported Externalizing Difficulties (RPAQ; *N* = 27).

Step/variable	R^2	ΔR^2	AIC	*B*	*SE B*	*t*	β
Step 1	.12	.12	7.62				
Gender (male = 0, female = 1)				0.22	0.53	0.41	.10
Age				0.12	0.21	0.57	.13
ADHD subtype (inattentive = 0, combined = 1)				0.35	0.52	0.68	.17
Medication status (no medication = 0, medication = 1)				0.04	0.49	0.08	.02
ERC total (overall emotion regulation)							
Step 2	.12	.00	9.61				
EMA parent-report mean TA				−0.01	0.07	−0.03	−.01
Step 3	.47	.36***	−2.27				
Parent-report TA MSSD (emotional impulsivity)				0.05	0.01	3.56	.65***

Note. RPAQ = Reactive-Proactive Aggression Questionnaire–Proactive; AIC = Akaike Information Criteria; ERC = Emotion Regulation Checklist; EMA = ecological momentary assessment; TA = total affect; MSSD = mean squared successive difference.
*p < .10. **p < .05. ***p < .01. ****p < .001.

Relation of emotional impulsivity to externalizing difficulties. Results supported the hypothesis that parent-reported emotional impulsivity was related to the behavioral difficulties of children with ADHD (see Tables 4 and 5, and Figure 2), as results suggested the model fit was substantially improved by inclusion of parent-reported PANAS TA MSSD in the estimation of CBCL-Externalizing, $\Delta R^2 = .07$, $p < .05$, AIC = 107.83, ΔAIC = −3.95, and RPAQ-Proactive Aggression scores, $\Delta R^2 = .36$, $p < .005$, AIC = −2.27, ΔAIC = −9.89. Results indicated that PANAS TA MSSD scores were significantly associated with behavioral difficulties given the current set of variables, such that children with greater PANAS TA MSSD scores also had higher CBCL-Externalizing, β = .29, $t = 2.16$, 95% CI = [0.01, 0.44], $p < .05$, and RPAQ-Proactive Aggression scores, β = .65, $t = 3.58$, 95% CI = [0.02, 0.08], $p < .005$. Results indicated that the covariates entered into the first step substantially improved the estimation of CBCL-Externalizing, $\Delta R^2 = .51$, $p < .01$, AIC = 117.80, although none of the covariates was incrementally related to CBCL-Externalizing. Inclusion of PANAS mean TA in the second step also substantially improved the estimation of CBCL-Externalizing given the current set of variables, $\Delta R^2 = .13$, $p < .05$, AIC = 111.78, with children who were less affectively expressive experiencing greater

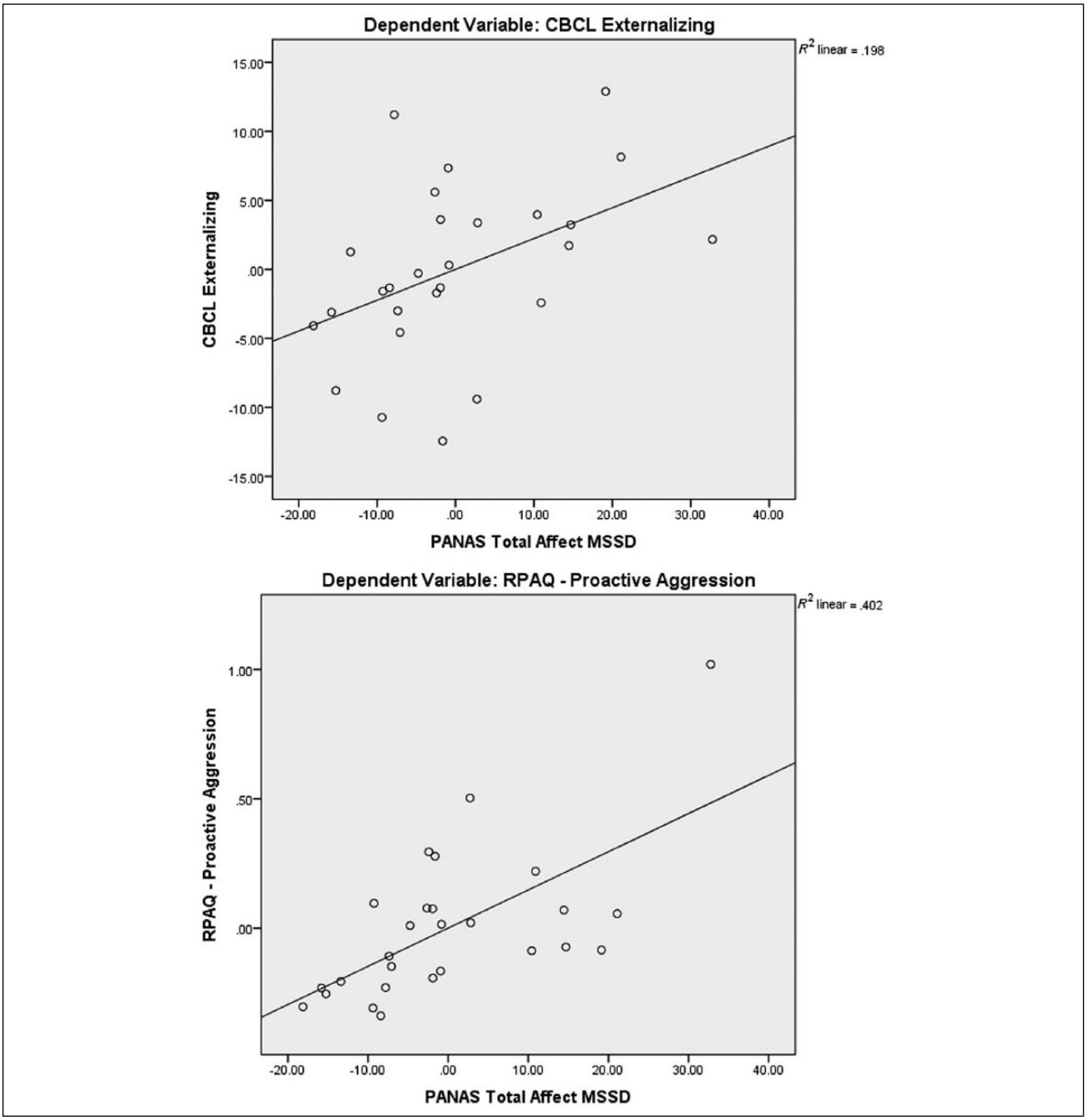

Figure 2. Scatterplots of partial correlation of emotional impulsivity (PANAS TA MSSD) and externalizing difficulties (CBCL-Externalizing, RPAQ).

Note. PANAS = Positive and Negative Affect Scale; TA = total affect; MSSD = Mean squared successive difference; CBCL = Child Behavior Checklist; RPAQ = Reactive-Proactive Aggression Questionnaire.

parent-reported externalizing difficulties, $\beta = -.39$, $t = -2.63$, 95% CI = [−2.15, −0.25], $p < .05$. Results indicated that neither the covariates ($\Delta R^2 = .12$, $p > .70$, AIC = 7.62) nor the PANAS mean TA score ($\Delta R^2 = .01$, $p > .80$, AIC = 9.61) substantially improved the fit of the current model to the estimation of RPAQ-Proactive Aggression. The overall model was well fit to parent-reported, $R^2 = .70$, $F(7, 19) = 6.47$, $p < .001$ and child-reported externalizing difficulties,

$R^2 = .47$, $F(7, 19) = 2.43$, $p < .05$. Overall, results suggested that children who demonstrated greater emotional impulsivity over the 4-week EMA period experienced substantially more parent-reported and self-reported behavioral difficulties. Encouragingly, this effect was evident in within-rater and across-rater analyses.

Contribution of negative and positive emotional impulsivity to internalizing and externalizing difficulties. As the TA scores are created by summing the PA and NA scores, post hoc analyses examined the unique contributions of parent-reported PA and NA to the prediction of children's internalizing and externalizing difficulties. The previously described regressions were repeated using separate PA and NA mean and MSSD scores rather than the summed TA score. PA and NA scores were entered simultaneously at each step to allow for examination of unique contributions to estimation. Results did not suggest that mean overall levels of PA (β = −.13, $t = -0.57$, 95% CI = [−1.91, 1.09], $p > .50$) or NA (β = .27 $t = 1.23$, 95% CI = [−2.78, −10.63], $p > .20$) contributed uniquely to the estimation of parent-reported internalizing difficulties. Interestingly, results indicated a uniquely strong relation of PA MSSD (β = .46, $t = 2.20$, 95% CI = [0.02, 0.75], $p > .05$) but not NA MSSD (β = −.06) to parent-reported internalizing difficulties given the current set of variables, suggesting that children with greater variability and intensity of PA were experiencing more internalizing difficulties regardless of NA. Similarly, results suggested a strong relation of overall mean PA to children's self-reported internalizing difficulties given the current set of variables, β = −.49, $t = -2.14$, 95% CI = [−4.32, −0.04], $p > .05$, such that children who demonstrated lower levels of overall PA across the 4 weeks of EMA rated themselves as experiencing greater internalizing difficulties. However, minimal relation was observed between child-reported internalizing difficulties and the overall NA (β = .16) or positive or negative emotional impulsivity (βs = .20-.42, ps > .15) in the current sample.

Analyses also examined the impact of PA and NA on externalizing difficulties among children with ADHD. Results suggested that neither overall PA nor overall NA was strongly associated with parent-reported externalizing difficulties, as effect sizes were small (βs = −.17 to −.30, ps > .10). Similarly, no relation was evident between parent-reported externalizing difficulties and positive or negative emotional impulsivity (βs = .20-.22, ps > .20). A similar pattern was evident in analyses of child-reported proactive aggression, as the RPAQ-Proactive Aggression score was not strongly associated with overall PA or NA (βs = −.01 to. 02, ps > .90) or positive or negative emotional impulsivity (βs = .32-.45, ps > .20) in the current sample.

Discussion

The current findings demonstrate the validity and utility of using EMA-based methodologies to examine the emotional variability of children with ADHD and present a first step toward identifying how these patterns of emotional variability impact the emotional and behavioral functioning of children with ADHD. Overall, results suggested that EMA is a feasible and valuable means of assessing the day-to-day emotional experience of children, as parents and children were able to adhere to the EMA protocol over the length of the study. Results supported the hypothesis that emotional impulsivity is related to greater emotional and behavioral difficulties among children with ADHD, as children who demonstrated more variable and intense emotions over the length of the EMA protocol experienced greater concurrent parent-rated and self-reported emotional and behavioral difficulties. EMA methodologies demonstrated incremental validity, as the relation of EMA-derived emotional impulsivity to emotional and behavioral difficulties was evident even after controlling for retrospective report of emotion regulation difficulties.

Validity and Utility of EMA-Based Assessment

Parents and children were able to adhere to a three times per day EMA protocol over an extended period of time, as all parents and the vast majority of children were able to complete more than 60% of all rating points and both groups averaged greater than 75% completion of intervals. This was particularly encouraging as this adherence rate was maintained despite an assessment protocol that was significantly longer (28 days) than many studies that have used EMA with children or families (i.e., Suveg et al. 2010; Whalen et al., 2006; Whalen et al., 2009). However, although parents and children demonstrated adherence to the study protocol, results suggested that the children's level of affective distress may have affected children's completion rates. Specifically, results indicated that children were rated as significantly more distressed during intervals that they failed to complete than during intervals that they completed. Of note, parents provided their ratings of the child's affect prior to asking the child to complete ratings, thus the parent ratings were unaffected by the child's willingness or unwillingness to complete ratings. However, it is possible that parents were less likely to encourage their children to complete ratings during intervals where the parent perceived the child as more distressed. Regardless, it is likely that the children's inability or unwillingness to complete intervals where they were more distressed contributed to the low concordance between parent and child EMA-based ratings of the child's affect and the overall lack of utility of the child's self-ratings of emotional impulsivity in the prediction of the child's overall emotional and behavioral difficulties. Overall, the EMA methodology used in this study demonstrated feasibility and utility as a means of assessing patterns of day-to-day

variation in parent's perceptions of children's affect, but only demonstrated limited utility as a means of assessing children's daily self-reports of their own affect.

Theoretical Implications

ADHD in children rarely occurs in isolation, with some studies estimating that greater that 50% of children with ADHD meet criteria for a comorbid emotional or behavioral disorder (Strine et al., 2006). Results of this study supported the hypothesized associations between emotional impulsivity and internalizing and externalizing difficulties in children with ADHD. Specifically, results indicated that internalizing and externalizing difficulties in children with ADHD were strongly related to the frequency and intensity with which their overall affect varied over time, and that this affective variability was incrementally related to internalizing and externalizing difficulties above and beyond the effects of the child's global emotionally dysregulated behavior and the child's overall levels of expressed affect. Studies have consistently demonstrated high rates of internalizing and externalizing difficulties among children with ADHD (Strine et al., 2006), and emotional impulsivity has emerged as a possible mediating factor (Anastopolous et al., 2011; Barkley, 2010). Indeed, evidence has increasingly suggested that the inability to control emotional reactions and moderate affective variability may be a potent risk factor in the development of emotional distress, behavioral difficulties, and functional impairment among children with ADHD (Anastopolous et al., 2011). Results of the current study strongly supported this theory and indicated that children with ADHD who were more emotionally impulsive experienced substantially more impaired emotional and behavioral functioning.

Although previous studies have established a link between emotional dysregulation and emotional and behavioral impairment, this study is the first to date to examine how longitudinal patterns of variability and intensity of PA, NA, and TA co-occur with internalizing and externalizing problems in children with ADHD. Notably, the results in this study indicated that this pattern of impairment was more strongly linked to variability in *total* demonstrated affect than it was to variability in PA or NA. Indeed, children with greater internalizing and externalizing problems were characterized by a pattern of frequent changes in intensity in TA, suggesting that children who experience greater emotional and behavioral impairment demonstrated instability and frequent surges of intensity in PA *and* NA.

Implications for Interventions

The results of this study have significant and potentially far-reaching implications for the development of interventions for children with ADHD. Results of this study suggest that emotional and behavioral difficulties are likely more severe in children who experience more variability and more intense shifts in affect. Well-validated psychotropic and psychosocial interventions currently exist for the inattention, overactivity, and impulsivity that are fundamental to ADHD, including stimulant medications and behavioral parent training (Pelham, Wheeler, & Chronis, 1998). Although these approaches have demonstrated substantial efficacy in treating the core symptoms and related functional behavioral difficulties of children with ADHD, these approaches do not address the emotional dysregulation and emotional impulsivity that may be instrumental in the development of emotional and behavioral impairment among children with ADHD (Graziano, McNamara, Geffken, & Reid, 2013). Indeed, Waxmonsky et al. (2013) noted that no treatment to date has been developed specifically to address the emotional difficulties common to ADHD. This gap in the literature is particularly pronounced given the increasing evidence of the importance of emotion dysregulation in the development of mixed internalizing-externalizing difficulties among children with ADHD (Anastopolous et al., 2011; Martel, 2009; Sobanski et al., 2010).

The results of this study highlight the critical need for further development of interventions for children with ADHD that address emotional impulsivity and regulation as well as attentional and behavioral symptoms. Indeed, studies have indicated that emotion dysregulation is at least partially responsible for the greater emotional and behavioral difficulties, functional impairment (Anastopolous et al., 2011), and parental stress experienced by children with ADHD (Graziano et al., 2013). Similarly, studies have indicated that children with ADHD who show improved emotional and behavioral functioning in response to psychosocial treatment show concordant changes in neurological regions associated with emotion regulation (i.e., ventral prefrontal activation; Lewis et al., 2008). Emotion regulation is not a unitary construct; however, the current study suggests that emotional impulsivity is particularly strongly linked with emotional and behavioral difficulties among children with ADHD. Children in this study with emotional and behavioral difficulties were rated by their parents as experiencing frequent and intense shifts in affect, suggesting a pattern of strong and intense emotional reactivity to positive and negative stimuli. Notably, this pattern was linked to greater emotional and behavioral difficulties even after controlling for overall emotion regulation abilities. It is thus particularly important that interventions focus on helping children with ADHD recognize and cope with emotional impulsivity to allow them to reduce the frequency and intensity of their impairing emotional reactivity.

Limitations

This study provided encouraging support for the association of EMA-derived emotional impulsivity with emotional

and behavioral difficulties among children with ADHD. However, several limitations must be acknowledged. This study represented an initial examination of the feasibility and validity of EMA in the assessment of emotional impulsivity. Although this study demonstrated a robust relation of emotional impulsivity to internalizing and externalizing difficulties, all data in this study were obtained concurrently. It is thus not possible to deconstruct the direction of the effects demonstrated in this study. Further studies are needed to demonstrate the longitudinal direction of this relation to determine whether the emotional impulsivity assessed in this study is a cause or result of greater internalizing and externalizing behavior in children. EMA presents several limitations as well. EMA-based ratings allow for multiple assessments of mood but do not provide information about context of the ratings. It was thus not possible to draw conclusions regarding why a child's ratings were elevated or decreased at any time point. In addition, the study did not have the capacity to collect EMA data (child- or teacher report) during the school day. As school is often an area of significant difficulty for children with ADHD, the study may have underestimated emotional impulsivity for children in the current study. However, given that the statistic used in this study to determine emotional impulsivity (MSSD) can be artificially inflated when there is environmental or reporter variance between consecutive intervals, the present results may best be interpreted as an accurate representation of the child's emotional impulsivity within the home setting.

The failure of the child-reported EMA-derived measures to demonstrate any relation with child- or parent-reported internalizing or externalizing behavior in the current analyses represents another limitation within this study. Indeed, results suggested that children were significantly less likely to complete the EMA measures when they were experiencing NA, which suggests that EMA methodologies may be somewhat less useful when assessing child versus parent report. However, results suggested that parent-reported EMA measures were significantly related to parent- and child report of internalizing and externalizing behavior, suggesting that parent report is likely a valid indicator of emotional impulsivity over time. Finally, the small sample in the study presents several limitations. The small sample size may have reduced the power of the analyses to detect small but meaningful effects. However, the analyses in the current study were intended to be exploratory rather than confirmatory, and analyses were able to demonstrate substantial relations of emotional impulsivity to internalizing and externalizing difficulties in children despite the small sample size. Similarly, the small sample size precluded examining differences according to gender, subtype, or medication status, although results indicated that effects remained significant after controlling for gender, subtype, and medication status. Finally, numerous regression analyses were conducted to ensure that analyses accounted for parent- and child report of internalizing and externalizing problems. Conducting multiple analyses increases the risk of false positive findings (particularly within the context of significance testing). However, as the analyses were intended to be exploratory in nature (and were not dependent on significance testing), it was decided to leave the results uncorrected. Accordingly, further studies are needed with larger sample size to determine the robustness of the findings across multiple samples.

Conclusion

The current study presents a critical step toward understanding the crucial relation of emotion dysregulation, including the powerful effects of emotional impulsivity over time on the emotional and behavioral functioning of children with ADHD. Emotional impulsivity likely has profound and far-reaching effects on children with ADHD, as their inability to intense and variable emotional reactions inhibits their ability to cope with distress, control their emotions, and engage in prosocial behavior. Instead, children with ADHD who are more emotionally impulsive respond to emotionally evoking stimuli with excessively intense emotional reactions, leading to a pattern of emotionally driven processing and behavior (Rosen, Milich, & Harris, 2012). That this pattern persists despite controlling for medication status, subtype, and overall emotion dysregulation speaks to the pervasive effects of emotional impulsivity and the ineffectiveness of current interventions at reducing emotional impulsivity. Our hope is that by improving our understanding of how emotional reactivity, variability, and intensity affect children with ADHD, we can improve our ability to assess and treat this difficulty and improve the emotional and behavioral functioning of children with ADHD.

Declaration of Conflicting Interests

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References

Achenbach, T. M. (2001). *Manual for the Child Behavioral Checklist/6-18 and 2001 Profile*. Burlington: Department of Psychiatry, University of Vermont.

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

Anastopolous, A. D., Smith, T. F., Garrett, M. E., Morrissey-Kane, E., Schatz, N. K., Sommer, J. L., & Ashley-Koch, A. (2011). Self-regulation of emotion, functional impairment, and comorbidity among children with ADHD. *Journal of Attention Disorders*, *15*, 583-592.

Barkley, R. A. (2010). Deficient emotion regulation is a core component of ADHD. *Journal of ADHD and Related Disorders*, *1*, 5-37.

Ebner-Priemer, U. W., & Trull, T. J. (2009). Ecological momentary assessment of mood disorders and mood dysregulation. *Psychological Assessment*, *21*, 463-475.

Graziano, P. A., McNamara, J. P., Geffken, G. R., & Reid, A. M. (2013). Differentiation co-occuring behavior problems in children with ADHD: Patterns of emotional reactivity and executive functioning. *Journal of Attention Disorders*, *17*, 249-260. doi: 10.1177/1087054711428741.

Hessler, D. M., & Katz, L. F. (2007). Children's emotion regulation: Self-report and physiological response to peer provocation. *Developmental Psychology*, *43*, 27-38.

Jahng, S., Wood, P. K., & Trull, T. J. (2008). Analysis of affective instability in ecological momentary assessment: Indices using successive difference and group comparison via multilevel modeling. *Psychological Methods*, *13*, 354-375.

Jensen, S. A., & Rosen, L. A. (2004). Emotional reactivity in children with attention-deficit/hyperactivity disorder. *Journal of Attention Disorders*, *8*, 53-61.

Kovacs, M. (1992). *The Children's Depression Inventory (CDI)*. Toronto, Ontario, Canada: Multi-Health Systems.

Laurent, J., Catanzaro, S. J., Joiner, T. E., Rudolph, K. D., Potter, K. I., Lambert, S., & Gathright, T. (1999). A measure of positive and negative affect for children: Scale development and preliminary validation. *Psychological Assessment*, *11*, 326-338.

Lewis, M. D., Granic, I., Lamm, C., Zelazo, P. D., Stieben, J., Todd, R. M., & Pepler, D. (2008). Changes in the neural bases of emotion regulation associated with clinical improvement in children with behavior problems. *Development and Psychopathology*, *20*, 913-939.

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.

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

Miller, D. J., Vachon, D. D., & Lynam, D. R. (2009). Neuroticism, negative affect, and negative affect instability. Establishing convergent and discriminant validity using ecological momentary assessment. *Personality and Individual Differences*, *47*, 873-877.

Norvilitis, J. M., Casey, R. J., Brooklier, K. M., & Bonello, P. J. (2000). Emotion appraisal in children with attention-deficit/hyperactivity disorder and their parents. *Journal of Attention Disorders*, *4*, 15-26.

Pelham, W. E., Wheeler, T., & Chronis, A. (1998). Empirically supported psychosocial treatments for attention deficit hyperactivity disorder. *Journal of Clinical Child Psychology*, *27*, 190-205.

Phillips, B. M., Lonigan, C. J., Driscoll, K., & Hooe, E. S. (2002). Positive and negative affectivity in children: A multitrait-multimethod investigation. *Journal of Clinical Child & Adolescent Psychology*, *31*, 465-479.

Piasecki, T. M., Hufford, M. R., Solhan, M., & Trull, T. J. (2007). Assessing clients in their natural environments with electronic diaries: Rationale, benefits, limitations, and barriers. *Psychological Assessment*, *19*, 25-43.

Porges, S. W., Doussard-Roosevelt, J. A., & Maiti, A. K. (1994). Vagal tone and the physiological regulation of emotion. *Monographs of the Society for Research in Child Development*, *59*, 167-186.

Raine, A., Dodge, K., Loeber, R., Gatzke-Kopp, L., Lynam, D., Reynolds, C., & Liu, J. (2006). The reactive-proactive aggression questionnaire: Differential correlates of reactive and proactive aggression in adolescent boys. *Aggressive Behavior*, *32*, 159-171.

Rosen, P. J., & Epstein, J. N. (2010). A pilot study of ecological momentary assessment of emotion dysregulation in children. *Journal of ADHD and Related Disorders*, *1*, 39-52.

Rosen, P. J., Milich, R., & Harris, M. J. (2012). Dysregulated negative emotional reactivity as a predictor of chronic peer victimization in childhood. *Aggressive Behavior*, *38*, 414-427.

Shaffer, D., Fisher, P., Lucas, C. P., Dulcan, M. K., & Schwab-Stone, M. E. (2000). NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): Description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child & Adolescent Psychiatry*, *39*, 28-38.

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

Shrier, L. A., Shih, M.-C., & Beardslee, W. R. (2005). Affect and sexual behavior in adolescents: A review of the literature and comparison of momentary sampling with diary and retrospective self-report methods of measurement. *Pediatrics*, *115*, 573-581.

Skirrow, C., McLoughlin, G., Kuntsi, J., & Asherson, P. (2009). Behavioral, neurocognitive, and treatment overlap between attention-deficit/hyperactivity disorder and mood instability. *Expert Review of Neurotherapeutics*, *9*, 489-503.

Sobanski, E., Banaschewski, T., Asherson, P., Buitelaar, J., Franke, B., Holtmann, M., & Faraone, S. V. (2010). Emotional lability in children and adolescents with attention-deficit/hyperactivity

disorder (ADHD): Clinical correlates and familial prevalence. *Journal of Child Psychology and Psychiatry*, *51*, 915-923.

Solhan, M. B., Trull, T. J., Jahng, S., & Wood, P. K. (2009). Clinical assessment of affective instability: Comparing EMA indices, questionnaire reports, and retrospective recall. *Psychological Assessment*, *21*, 425-436.

Stone, A. A., & Shiffman, S. (1994). Ecological momentary assessment (EMA) in behavioral medicine. *Annals of Behavioral Medicine*, *16*, 199-202.

Strine, T. W., Lesesne, C. A., Okoro, C. A., McGuire, L. C., Chaoman, D. P., Balluz, L. S., & Mokdad, A. H. (2006). Emotion and behavioral difficulties and impairments in everyday functioning among children with a history of attention-deficit/hyperactivity disorder. *Preventing Chronic Disease*, *3*, 1-10.

Suveg, C., Payne, M., Thomassin, K., & Jacob, M. L. (2010). Electronic diaries: A feasible method of assessing emotional experiences in youth? *Journal of Psychopathology and Behavioral Assessment*, *32*, 57-67.

Thompson, E. R. (2007). Development and validation of an internationally reliable short-form of the Positive and Negative Affect Schedule (PANAS). *Journal of Cross-Cultural Psychology*, *38*, 227-242.

U.S. Census Bureau. (2010). *State and county QuickFacts* (Data derived from population estimates, American Community Survey, Census of Population and Housing, County Business Patterns, Economic Census, Survey of Business Owners, Building Permits, Consolidated Federal Funds Report, Census of Governments). Retrieved from http://quickfacts.census.gov/qfd/states/21/2148006.html

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

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063-1070.

Waxmonsky, J. G., Wymbs, F. A., Pariseau, M. E., Belin, P. J., Waschbusch, D. A., Babocsai, L., & Pelham, W. E. (2013). A novel group therapy for children with ADHD and severe mood dysregulation. *Journal of Attention Disorders*, *17*, 527-541. doi: 10.1177/1087054711433423.

Weiss, H. M., Beal, D. J., Lucy, S. L., & MacDermid, S. M. (2004). *Conducting EMA Studies with PMAT: The Purdue Momentary Assessment Tool User's Manual*. West Lafayette, IN: Purdue University.

Whalen, C. K., Henker, B., Ishikawa, S. S., Floro, J. N., Emmerson, N. A., Johnston, J. A., & Swindle, R. (2009). ADHD and anger contexts: Electronic diary mood reports from mothers and children. *Journal of Pediatric Psychology*, *34*, 940-953.

Whalen, C. K., Henker, B., Jamner, L. D., Ishikawa, S. S., Floro, J. N., Swindle, R., & Johnston, J. A. (2006). Toward mapping daily challenges of living with ADHD: Maternal and child perspectives using electronic diaries. *Journal of Abnormal Child Psychology*, *34*, 115-130.

Author Biographies

Paul J. Rosen, PhD, is an assistant professor of psychology at the University of Louisville and the director of the RACER (Research on ADHD and Children's Emotion Regulation) Lab. His research focuses primarily on the impact of emotion regulation on children with and without ADHD.

Perry I. Factor is a graduate student in clinical psychology at the University of Louisville. His research focuses primarily on comorbid internalizing and externalizing disorders within ADHD.