ADHD and Anger Contexts: Electronic Diary Mood Reports from Mothers and Children

Carol K. Whalen,1 PhD, Barbara Henker,2 PhD, Sharon S. Ishikawa,1 PhD, Joshua N. Floro,1 MA, Natasha A. Emmerson,1 MA, Joseph A. Johnston,3 MD, MSc, and Ralph Swindle,3 PhD
1University of California, Irvine, 2University of California, Los Angeles and 3Eli Lilly & Company

Objective  Using electronic diaries (eDiaries), this study examined temporal links between child and maternal anger, as well as positive mood and perceived stress, in children with attention–deficit/hyperactivity disorder (ADHD) versus comparison peers.  Methods  Across 7 days, half-hourly eDiaries were completed independently by mothers and their 8–12-year-old children (51 receiving medication for ADHD and 58 comparison peers).  Results  Cross-informant analyses revealed systematic patterns of negative maternal moods in relation to child anger in both groups along with evidence of slower recovery in the ADHD group. Analogously, for both groups, children’s anger reports increased and good-mood reports decreased in relation to maternal anger, whereas elevated stress in relation to maternal anger was restricted to children with ADHD.  Conclusions  The findings indicate that a negative affective climate is more likely to persist in ADHD than in comparison families. They also affirm the utility of child as well as parent eDiary reports and suggest that children may be willing to report low positive mood when reluctant to report negative mood. The promise of incorporating real-time data on mood patterning into tailored treatments for children with ADHD and their families is discussed.

Key words  anger; ADHD; electronic diaries; moods; mother–child relationships.

The core features of attention–deficit/hyperactivity disorder (ADHD) such as inattention, restlessness, impulsivity, and executive dysfunction create challenges not only for diagnosed children but also for their families, often augmenting the usual perils and pitfalls of parenting. Although the literature is not totally consistent, elevated rates of contentious interactions and troubled relationships have been observed in these families, and longitudinal as well as concurrent associations between negative parent–child relationships and externalizing disorders in children and adolescents have been repeatedly documented across samples, settings, and measures (Johnston & Mash, 2001; Waschbusch, 2002). Parents of children with ADHD perceive their relationships with their children more negatively (Gerdes, Hoza, & Pelham, 2003); view their families as higher in conflict (Pressman et al., 2006); and report lower levels of parenting satisfaction and self-efficacy (Johnston & Mash, 2001). Such adverse family climates may serve to maintain or exacerbate child problem behaviors and mediate not only symptom severity but also treatment responsiveness and long-term outcomes (Hinshaw et al., 2000; Jacobvitz, Hazen, Curran, & Hitchens, 2004). Although debate continues over the extent to which associations between family conflict and problematic child behavior are child driven, parent driven, or bidirectional, the emerging consensus is that the effects are reciprocal, with parents and children contributing over time to an escalating spiral of parent–child conflict and child externalizing problems (Burt, McGue, Krueger, & Iacono, 2005; Patterson, Reid, & Dishion, 1992).

Most studies of parent–child relationships have relied on either questionnaires or structured interactions in laboratory or clinic settings. These studies have been highly informative, but the findings are constrained by multiple methodological limitations. Questionnaire responses are vulnerable to subjectivity, ambiguity, recall bias, and impression management. Structured interaction tasks, usually brief and contrived, may capture glimpses of “best” or “public” behavior rather than more typical patterns. Almost nothing is known about the naturally-occurring,
fine-grained interplay between the affective and behavioral worlds of parents and those of their children.

**Experience Sampling Using eDiaries**

Experience sampling (ES) or ecological momentary assessment overcomes some of the limitations of traditional approaches and provides an opportunity to extend laboratory and questionnaire studies to natural settings. This approach provides frequent probes into the ongoing stream of behavior, collecting precise information in real time. Early ES studies used paper-and-pencil diaries at timed intervals, but recent and ongoing technological advances have increased the feasibility and cost-effectiveness of eDiaries, using personal digital assistants (PDAs) or smart phones. One advantage is that responses are time-stamped, and respondents cannot engage in “waiting room compliance,” that is, completing several scheduled diaries immediately before the lab or office visit. Another advantage is confidentiality, likely accompanied by increased candor, because responses disappear from the screen as soon as they are entered and thus cannot be accessed by curious others. A third advantage is ease of data handling and reduction of data entry errors because responses are downloaded directly from the PDA. The value and relative advantages of eDiaries have been documented extensively in both medical and psychological research (Dale & Hagen, 2007), including studies of such diverse topics as pain (Stone & Broderick, 2007), adolescent moods and smoking behavior (Whalen, Jamner, Henker, & Delfino, 2001), and physical activity (Dunton, Whalen, Jamner, & Floro, 2007).

In the vast majority of eDiary studies conducted to date, the respondents have been individual adults or adolescents. Little is known about the utility of these approaches with children or in dyadic contexts. Although the inclusion of the child’s perspective when assessing child behavior problems is typically touted, there often are marked discrepancies between information obtained from children and that provided by parents or teachers who know the child well (De Los Reyes & Kazdin, 2005; Karver, 2006). The veridicality of children’s self-assessments, especially those involving negative affect and undesirable behaviors, is always suspect because children may have neither the cognitive maturity nor the motivation to reflect on their shortcomings and provide candid self-reports. But the fallibility of child self-reports must be weighed against the pitfalls of relying on a single source, usually the mother, for information about both parent and child.

In two recent studies, we demonstrated that children as well as mothers can use eDiaries to report their moods, perceptions, and behaviors on an ongoing basis throughout the day (Whalen, Henker, Ishikawa, et al., 2006; Whalen, Henker, Jamner, et al., 2006). Comparing families with and without a child with ADHD, these studies documented elevated rates of symptomatic behaviors and negative moods in the children with ADHD as well as lower levels of maternal parenting satisfaction and family quality of life. The findings for negative moods and interactions were particularly striking. Mothers in the ADHD group were more likely than comparison mothers to report anger when they were with their children, and children as well as mothers in the ADHD group reported three to four times as much disagreement or discord.

**Momentary Moods in Family Context: Anger, Perceived Stress, and Good Mood**

Multiple studies have demonstrated that unpleasant and even antagonistic interactions occur more frequently in families that have a child with ADHD than in other families, and consistent with a transactional model, these negative behaviors emanate from parents as well as from children (Edwards, Barkley, Laneri, Fletcher, & Metevia, 2001; Johnston & Mash, 2001; Whalen, Henker, Ishikawa, et al., 2006). Many children with ADHD are more irritable, argumentative, and noncompliant than their peers. Parents tend to be less positive and responsive and more directive and derogatory in their interactions with their children who have ADHD, especially when these children also show oppositionality (Buhrmester, Camparo, Christensen, Gonzalez, & Hinshaw, 1992; Seipp & Johnston, 2005).

Anger seems to be a pivotal construct that ties together diverse studies of family functioning in ADHD, as illustrated by Jacobvitz et al.’s (2004) finding that parental hostility when the child was 2 years of age predicted teacher-documented ADHD symptoms at age 7. Analogously, Denham et al. (2000) reported that parental anger predicted continuation of child behavior problems across a 2–4-year span from early to middle childhood, and that parental contributions were most influential for children who had the most serious behavior problems initially. Although anger expression is rarely an explicit empirical focus, it is often a major (if not the major) ingredient in the negative child and parent behaviors that are examined. For this reason, we focused on anger in this initial foray into cross-informant analyses of maternal and child moods. We examined not only temporal associations between maternal
and child anger, but also how anger relates to perceived stress and good mood on an ongoing basis.

Perceived stress was included because it is a key construct in understanding the impact, on quality of life, of caring for a family member with a chronic disorder such as ADHD (Anastopoulos, Guerremont, Shelton, & DuPaul, 1992). Moreover, in today's society, stress is often considered normative rather than maladaptive, and thus it may be acknowledged more readily than negative mood states such as anger.

As with stress, “good mood” was included for both a substantive and a methodological reason. First, research in diverse domains is delineating differential causes, concomitants, and consequences of positive versus negative moods (e.g., Charles, Reynolds, & Gatz, 2001), demonstrating the fallacy of assuming that lower levels of one imply higher levels of the other. Second, there are empirical indications that some people (especially children) may be more comfortable endorsing less of a good thing than more of a bad thing (Whalen, Henker, Jamner, et al., 2006), and thus reports of positive moods may be more informative than those of negative moods.

Research Questions and Hypotheses

The present study adds to our earlier findings by using an improved version of the eDiaries that enables closer temporal linking of maternal and child self-reports of moods. Two sets of analyses, mirror-images of each other, examined the anger contexts of mothers’ and children’s self-reported moods. In the analyses of maternal moods, the timing of child anger served as the independent variable. That is, when maternal moods were the targets or dependent variables, these moods were coded as either before an episode of child anger, after an episode, proximal to an episode, or nonproximal. In the parallel analyses of child moods, the timing of maternal anger was the independent variable, and the children’s moods were examined in temporal association to episodes of maternal anger. Two dual-pronged questions regarding moods in family context were addressed: First, to what extent are maternal mood patterns linked temporally to child anger, and do the patterns differ in families with and without a child with ADHD? Second, do children’s self-reported moods vary with maternal anger and, again, do the profiles differ in families with and without a child with ADHD? This cross-informant approach overcomes the methodological limitation endemic to most studies of child behavior problems in which a single source, typically the mother, provides all of the information.

In asking whether real-time cross-informant reports in natural settings would yield meaningful associations between maternal and child moods, we examined three sets of hypotheses. The first concerned what might be termed ambient or baseline mood levels. We predicted that mothers of children with ADHD would report more anger and stress and fewer good moods in general than would mothers of comparison children. These hypotheses are based on previous research documenting (a) elevated rates of difficult and contentious behaviors in children with ADHD and (b) in their mothers, depressive, inattentive/impulsive, or other psychosocial characteristics that heighten the challenges of parenting (Edwards et al., 2001; Johnston & Mash, 2001). The second set of hypotheses concerned duration or recovery rates and was based, in part, on Patterson’s theory of family coercive processes (Patterson et al., 1992). Here the predictions were that, following episodes of child anger, mothers of children with ADHD would not return to their own baseline levels as rapidly as would comparison mothers. Focused on children’s mood reports, the third hypothesis predicted that differences between children in the ADHD and comparison groups would emerge for positive but not for negative moods, because children with ADHD who are trying to “stay out of trouble” may find it safer to report lower levels of positive characteristics than higher levels of negative characteristics (Whalen, Henker, Jamner, et al., 2006).

Embedded in this study was a methodological question about whether child reports of their own negative affect (i.e., anger) have sufficient validity to function as “context” in an examination of maternal anger. More generally, can children as young as 8- to 12-years-old report meaningfully on their moods using eDiaries, and can high-density eDiary reports obtained independently but in close proximity from children and their mothers chart affective contexts in real-world settings?

Methods

Participants

There were 51 mother–child dyads (37 boys, 14 girls) in the ADHD group and 58 (35 boys, 23 girls) in the comparison group. Inclusionary criteria for the ADHD group were a diagnosis of ADHD and ongoing treatment for at least 2 months with long-acting medication, either a stimulant such as Adderall® or Concerta® (n = 26), or the nonstimulant atomoxetine (Strattera®, n = 25). Exclusionary criteria included a diagnosis of schizophrenia, pervasive developmental disorder, bipolar disorder, or prenatal drug exposure, and use of any psychotropic medication other than stimulants or atomoxetine. All of these...
children were on stable doses and were reported, by mothers, to be doing well on their medication. In addition to pharmacotherapy, 25 of these children were receiving behavioral or psychological intervention and seven were receiving academic tutoring. This was a community sample of children with ADHD who had been diagnosed and were being treated by their own physicians.

Eligibility for the study was documented in two phases. First, telephone screening included questions about the child’s diagnostic history; current diagnoses and any emotional, behavior, or learning problems; and medication regimen. Second, when the dyad appeared for their orientation visit, mothers were interviewed about the child using the ADHD section of the Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS; Kaufman et al., 1997). Children were eligible for the comparison group only if they had no history of behavior or learning problems and were not taking any psychoactive medications, according to maternal report.

Additional exclusionary criteria for both groups included lack of fluency in written English or problems with vision, hearing, or mobility that could interfere with using the PDAs. Enrollment was limited to mother–child dyads that, during the monitoring week, spent at least 6 h together each weekend day and 4 h together each weekday, including at least 45 min before school. Three prospective ADHD dyads and 25 prospective comparison dyads did not meet the time-together criterion and thus were not enrolled. Participants were recruited through e-mail announcements, newspaper advertisements, and flyers distributed to local schools and community physicians.

This was a middle-income, educated sample, with 76% of mothers having earned an A.A. or higher degree. As can be seen in Table I, there were no significant group differences in child or maternal age, child gender, family size, family income, maternal education level, or marital status. Data from 10 father–child dyads were also obtained but are not included.

### eDiary Monitoring

In order to sample a sufficient range of weekday and weekend experiences, eDiary monitoring was scheduled across 7 consecutive days during nonschool hours. The custom diary programs were installed on high-resolution Palm Tungsten PDAs (Palm, Inc., Sunnyvale, CA). All other computer functions (e.g., calendar, games) were locked out. Random schedules were generated such that each participant was signaled by a beep to complete a diary every 30 ± 6 min during the monitoring intervals (e.g., before and after school). If there was no response to the initial auditory signal, up to three reminder signals were emitted at 1-min intervals; the diary then became inaccessible until the next scheduled occurrence. The precise times that mother and child completed the diary could differ from the programmed schedule by several minutes, depending on which of the four possible signals elicited a report and how long the person spent answering.

To facilitate independent reporting, the schedules were programmed so that the child’s diary preceded the mother’s diary by 5 ± 2 min. We decided against counterbalancing mother–child order and instead used this fixed order for two reasons. First, we were concerned that the mother’s diary signal could cue a child to change behavioral course, and we wanted to minimize this type of reactivity. Second, a fixed schedule facilitated the pairing of mother and child reports.

Mother and child were instructed to complete their diaries independently and privately, without consulting with each other. Before starting, mothers were interviewed about the forthcoming week’s activities. To minimize disruption, the PDAs were programmed according to each family’s schedule, and time-out periods were inserted so that no signals were emitted during planned events such as soccer games.

### Table I. Demographic Characteristics and Psychosocial Assessments

<table>
<thead>
<tr>
<th></th>
<th>ADHD (N = 51)</th>
<th>COMP (N = 58)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
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<tr>
<td>Demographic characteristics</td>
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</tr>
<tr>
<td>Child age</td>
<td>10.63</td>
<td>1.23</td>
</tr>
<tr>
<td>Child gender (% boys)</td>
<td>72.5</td>
<td>60.3</td>
</tr>
<tr>
<td>Maternal age</td>
<td>41.51</td>
<td>5.24</td>
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<tr>
<td>Family size</td>
<td>4.24</td>
<td>1.19</td>
</tr>
<tr>
<td>Family income (% &gt;$100,000)</td>
<td>47.8</td>
<td>41.5</td>
</tr>
<tr>
<td>Maternal education (% attended college)</td>
<td>78.4</td>
<td>86.2</td>
</tr>
<tr>
<td>Marital status (% married)</td>
<td>82.4</td>
<td>82.8</td>
</tr>
<tr>
<td>Psychosocial measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBCL</td>
<td></td>
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</tr>
<tr>
<td>Internalizing</td>
<td>7.57</td>
<td>7.26</td>
</tr>
<tr>
<td>Externalizing</td>
<td>11.57</td>
<td>9.23</td>
</tr>
<tr>
<td>SNAP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>1.21</td>
<td>0.70</td>
</tr>
<tr>
<td>Inattention</td>
<td>1.68</td>
<td>0.65</td>
</tr>
<tr>
<td>Oppositional–defiant</td>
<td>1.18</td>
<td>0.81</td>
</tr>
<tr>
<td>DBSI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stressful events: Number</td>
<td>15.90</td>
<td>8.07</td>
</tr>
<tr>
<td>Stressful events: Intensity</td>
<td>30.60</td>
<td>19.94</td>
</tr>
</tbody>
</table>

ADHD: attention-deficit/hyperactivity disorder group; COMP: comparison group; CBCL: Child Behavior Checklist; SNAP: Swanson, Nolan, & Pelham DSM-IV Scale; DBSI: Disruptive Behavior Stress Inventory.

*p < .001.
Procedures

An initial telephone interview was conducted to ensure that prospective participants met the inclusionary and exclusionary criteria and to explain the eDiary procedures. After the mother indicated her willingness to participate with her child, she was asked to detail her weekly schedule, indicating which and how many hours she typically spent with her child each day of the week.

There were three phases during the 8-day course of this study: orientation, midweek review, and endpoint wrap-up. In the 2-h orientation, mother and child were seen separately to ensure voluntary participation, confidentiality, and sufficient opportunity for questions and answers. All procedures were explained; informed consent was obtained from the mother and assent from the child; and the mother was interviewed about the child’s problems using the K-SADS. Mothers also completed a measure of the child’s externalizing behavior problems (Swanson, Nolan, and Pelham DSM-IV scale or SNAP-IV; Swanson et al., 2001) as well as an inventory of child-related parenting stress, the Disruptive Behavior Stress Inventory or DBSI (Johnson & Reader, 2002). During orientation, mothers also completed questionnaires on their own psychological functioning. The Assessment of Hyperactivity and Attention Scale (AHA; Mehringer et al., 2002) was used to measure adult ADHD symptoms, and the Brief Symptom Inventory (BSI; Derogatis, 1993), a shortened form of the classic SCL-90-R, was used to assess psychiatric symptoms.

Also during orientation, the PDAs were introduced and demonstrated; the diary items and response options were reviewed; and mother and child each practiced completing the diary. A semi-structured, interactive training program was used to teach children how to use the 4-point scales and to ensure that they understood the meaning of each item. Working individually with a “coach,” the child watched a Power Point presentation that included brief clips from children’s films and was asked to take the perspective of the character featured in the clip (e.g., Woody from Toy Story, Nemo from Finding Nemo). After the clip, the child was asked, “If you were (character), how would you rate your (anger)?” If a child responded inappropriately, the coach redirected the child toward an appropriate response by asking the child to describe different elements from the clip that highlighted the mood (e.g., “What was the look on Woody’s face?” “What was the tone of Nemo’s voice?”). Care was taken to ensure that the children understood the scales and were comfortable using the PDA.

The 1-week eDiary monitoring began the following morning. Each dyad had a coach who was available to answer questions or resolve technical problems at any time during the monitoring week. The coaches were trained research staff, all college students or graduates, who were well versed in the study’s procedures and skilled at programming, downloading, and trouble-shooting the PDAs. The midweek review served to assess progress, enhance motivation after the initial novelty of the PDAs had worn off, address any questions, and download the data to date to ensure against loss. Mother and child were given feedback on their adherence rates, and the child was paid a bonus incentive of up to $10, depending on how many diaries had been completed.

The endpoint wrap-up session involved only the mother. The PDAs were returned; the data were checked, and mothers completed questionnaires about their child’s behaviors and general psychopathology (Child Behavior Checklist or CBCL; Achenbach & Rescorla, 2001) as well as their own experiences with the eDiaries. Mothers and children were each paid $100 for full participation. All procedures were approved by the Institutional Review Board of the University of California, Irvine.

Results

Sample Characteristics

All of the children in the ADHD group (and none in the comparison group) met DSM-IV criteria for ADHD, based on the maternal K-SADS interview. The breakdown by ADHD subtype was 34 (67%) ADHD-combined,
remarkable is the fact that six children and seven mothers' rates for the children were 91% and 94%. Especially 94% of diary signals, respectively, and the corresponding ADHD and comparison groups responded to 93% and mother during the monitoring week. (arangements such that the child was not living with the illness.)

The reasons given were the time demands, family illness (n = 2); and an unexpected change in custody arrangements such that the child was not living with the mother during the monitoring week (n = 1).

Adherence rates were quite high. Mothers in the ADHD and comparison groups responded to 93% and 94% of diary signals, respectively, and the corresponding rates for the children were 91% and 94%. Especially remarkable is the fact that six children and seven mothers responded to 100% of diary opportunities.

**Study Completion and Diary Adherence**

Three comparison dyads and two ADHD dyads dropped out of the study before completing the monitoring week. The reasons given were the time demands (n = 2); family illness (n = 2); and an unexpected change in custody arrangements such that the child was not living with the mother during the monitoring week (n = 1).

Adherence rates were quite high. Mothers in the ADHD and comparison groups responded to 93% and 94% of diary signals, respectively, and the corresponding rates for the children were 91% and 94%. Especially remarkable is the fact that six children and seven mothers responded to 100% of diary opportunities.

**Data Management and Analyses**

**Coding the Temporal Relationship of Mood Reports to Affective Context**

The temporal coding procedure is described using the example of child anger as the independent variable or affective context. The goal was to examine whether the mother's self-reported moods (i.e., anger, stress, good mood) were linked in time with the child's anger reports. The proximity of the mother's mood report to the child's anger was coded as follows. For an interval when the child reported anger, the mother's moods during the same interval were coded as **proximal** to child anger. If the mother's mood report occurred in the interval preceding and not proximal to or following a child anger report, the maternal observation was coded as **before** child anger. If the mother's mood report occurred in the interval after and not before or proximal to a child anger report, the maternal observation was coded as **after** child anger. If no child anger was reported before, proximal to, or after a maternal mood report, the maternal observation was coded as **nonproximal** to child anger. Mother and child had to have been together, according to maternal report, for instances to be coded as before, proximal to, or after child anger, but this constraint was not imposed for nonproximal instances.

**Statistical Analyses**

These analyses are based on 3,245 paired observations or diary reports from the ADHD group and 3,911 from the comparison group. For each group (ADHD and comparison), two parallel sets of cross-informant analyses were conducted and are reported below, both of which involve self-reports of anger. First, mothers' moods in temporal relation to children's self-reports of anger were examined. In these analyses, child anger was considered the affective context and maternal mood the target. Each temporal interval (e.g., proximal) was compared to each of the other temporal intervals (nonproximal, before, after).

Mood ratings were dichotomized for these analyses. For the negative moods (anger and stress), any rating above zero was considered an instance. For good mood, ratings of zero and one (not at all, just a little) were considered noninstances, whereas ratings of two and three (pretty much, very much) were considered instances. These criteria were applied in an attempt to minimize the social desirability and self-presentation biases that encourage people to overreport positive moods and underreport negative moods.

The data were analyzed using logistic regression with a repeated measures approach involving generalized estimating equations (GEEs) in the SAS generalized linear model procedure GENMOD. The GEE approach, a method for evaluating discrete and correlated data such as binary ratings of mood (Liang & Zeger, 1986), used an exchangeable correlation matrix and a logit link, with a robust estimator of the covariance matrix of regression coefficients. Data from both groups were analyzed in the same model, and separate estimates were derived from product terms of group by temporal intervals. Data are presented as mean proportions, which were obtained by first calculating, for each individual, the proportion of observations (diaries) in which the target mood was reported, and then calculating the mean proportion for each group. Because this is an early application of a new approach to parent–child assessment, the goal was to minimize Type 2 errors and no statistical corrections were made for multiple analyses. Results should be considered tentative until replicated.

For all analyses, mean proportions are presented in Tables II and III separately by group, and statistical test...
results are detailed in the text. There were no significant differences between boys’ and girls’ self-reported moods, nor did moods reported by mothers of sons differ from those reported by mothers of daughters.

Child Anger as Affective Context: Maternal Self-Reported Anger, Stress, and Good Mood in Temporal Relation to Child Self-Reported Anger

Maternal Anger

During nonproximal intervals, when no child anger was reported, mothers of children with ADHD endorsed anger almost twice as often as did those in the comparison group (OR = 1.78; 95% CI 1.19, 2.63; $\chi^2 = 8.23; p < .01$). Despite this overall elevation in the ADHD group, maternal anger appeared to vary systematically with child anger in both groups, as can be seen in Table II. Mothers of children with ADHD were more than twice as likely and comparison mothers were more than three times as likely to report anger proximal to child anger than during nonproximal intervals (ADHD: OR = 2.51; 95% CI 1.72, 3.64; $\chi^2 = 23.35; p < .001$; comparison: OR = 3.34; 95% CI 2.10, 5.32; $\chi^2 = 23.98; p < .001$). Anger reports by both groups of mothers were also elevated in intervals before and after child self-reported anger compared with nonproximal intervals (ADHD before: OR = 1.69; 95% CI 1.08, 2.65; $\chi^2 = 5.28; p < .05$; comparison before: OR = 2.26; 95% CI 1.35, 3.76; $\chi^2 = 9.70; p < .01$; ADHD after: OR = 2.05; 95% CI 1.25, 3.37; $\chi^2 = 8.13; p < .01$; comparison after: OR = 1.58; 95% CI 1.02, 2.41; $\chi^2 = 4.38; p < .05$). Of particular interest is the contrast between intervals proximal to and those immediately following child anger: Mothers in the comparison group showed a significant drop in anger in the interval following their child’s self-reported anger (OR = 0.47; 95% CI 0.28, 0.78; $\chi^2 = 8.41; p < .01$), whereas those in the ADHD group did not, and maternal anger rates following child anger were higher for mothers in the ADHD group than for those in the comparison group (OR = 2.32; 95% CI 1.16, 4.60; $\chi^2 = 5.75; p < .05$).

Maternal Stress

Overall, mothers in each group reported some level of stress about one-third of the time. As with anger, both groups of mothers reported substantially higher rates of stress proximal to child-reported anger than during nonproximal intervals (ADHD: OR = 2.40; 95% CI 1.77, 3.26; $\chi^2 = 31.95; p < .001$; comparison: OR = 2.21; 95% CI 1.46, 3.34; $\chi^2 = 14.21; p < .001$). A comparable pattern emerged when proximal intervals were compared with those occurring just before episodes of child anger (ADHD: OR = 1.80; 95% CI 1.18, 2.73; $\chi^2 = 7.54; p < .01$; comparison: OR = 1.62; 95% CI 1.04, 2.50; $\chi^2 = 4.66; p < .05$). Especially noteworthy was the finding that mothers in the ADHD group reported more stress after a child anger episode than during nonproximal intervals

<table>
<thead>
<tr>
<th>Maternal mood</th>
<th>Proximity to child anger</th>
<th>ADHD group (N = 51) Mean proportion (N Obs.)</th>
<th>Comparison group (N = 58) Mean proportion (N Obs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal anger</td>
<td>Nonproximal*</td>
<td>19.8 (543)&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
<td>12.2 (422)&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Before</td>
<td>29.4 (30)</td>
<td>23.8 (25)</td>
</tr>
<tr>
<td></td>
<td>Proximal</td>
<td>38.2 (97)</td>
<td>31.7 (69)&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>After*</td>
<td>33.6 (42)</td>
<td>17.9 (19)</td>
</tr>
<tr>
<td>Maternal stress</td>
<td>Nonproximal</td>
<td>35.3 (969)&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>28.4 (986)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Before</td>
<td>42.2 (43)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>35.2 (37)&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Proximal</td>
<td>56.7 (144)</td>
<td>46.8 (102)&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>After*</td>
<td>49.6 (62)</td>
<td>32.1 (34)</td>
</tr>
<tr>
<td>Maternal good mood</td>
<td>Nonproximal</td>
<td>80.6 (2215)&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>86.9 (3012)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Before</td>
<td>72.3 (74)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>82.9 (87)</td>
</tr>
<tr>
<td></td>
<td>Proximal*</td>
<td>58.7 (149)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>78.0 (170)</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>69.6 (87)</td>
<td>83.0 (88)</td>
</tr>
</tbody>
</table>

Significant ($p < .05$) within-group differences between temporal intervals: <sup>a</sup>nonproximal versus before. <sup>b</sup>nonproximal versus proximal. <sup>c</sup>nonproximal versus after. <sup>d</sup>proximal versus after. <sup>e</sup>before versus proximal. <sup>*</sup>ADHD versus comparison group difference, $p < .05$. 

Table II. Maternal Moods in the Context of Child Self-Reported Anger
Maternal Good Mood
In general, mothers endorsed good mood in over 80% of their diary reports. Even so, the overall (nonproximal) rates for mothers of children with ADHD were lower than those for comparison mothers (OR = 0.63; 95% CI 0.40, 0.98; \( \chi^2 = 4.10; p < .05 \)). For comparison mothers, the only change in relation to child anger was a drop in good mood rates during intervals proximal to child anger (OR = 0.54; 95% CI 0.33, 0.86; \( \chi^2 = 6.77; p < .01 \)). As can be seen in Table II, mothers in the ADHD group showed a steeper drop during proximal intervals (OR = 0.34; 95% CI 0.23, 0.49; \( \chi^2 = 34.78; p < .001 \)), and they were 60% less likely to report being in a good mood than were comparison mothers during intervals proximal to child anger (OR = 0.40; 95% CI 0.21, 0.74; \( \chi^2 = 8.56; p < .01 \)). In addition, a reduction in good mood reports by mothers in the ADHD group was seen following child anger episodes in contrast to nonproximal intervals (OR = 0.53; 95% CI 0.36, 0.84; \( \chi^2 = 7.89; p < .01 \)), whereas these rates did not differ among comparison mothers.

Taken together, these findings offer partial support for Hypothesis 1. Mothers of children with ADHD, in contrast to comparison mothers, reported higher rates of anger and fewer good moods, but overall rates of stress did not differ. Hypothesis 2 was also supported: Following child anger episodes, mothers of children with ADHD did not return to their baseline levels as quickly as did comparison mothers.

Maternal Anger as Affective Context: Child Self-Reported Anger, Stress, and Good Mood in Temporal Relation to Maternal Self-Reported Anger
Child Anger
In contrast to the overall group difference that emerged for maternal anger rates, children in the ADHD and comparison groups reported similar rates of anger during intervals nonproximal to maternal anger (9.0% and 7.0%, respectively, ns; Table III). Both groups of children reported anger more than twice as often during intervals proximal to maternal anger than during nonproximal intervals (ADHD: OR = 2.18; 95% CI 1.52, 3.12; \( \chi^2 = 17.99; p < .001 \); comparison: OR = 2.58; 95% CI 1.63, 4.08; \( \chi^2 = 16.51; p < .001 \)). Also, both groups were elevated when proximal intervals were contrasted with those just before episodes of maternal anger (ADHD: OR = 1.85; 95% CI 1.09, 3.12; \( \chi^2 = 5.27; p < .05 \); comparison: OR = 2.35; 95% CI 1.30, 4.25; \( \chi^2 = 7.96; p < .01 \)). These elevated levels of child anger were shortened, as indicated by reductions in both groups during intervals that followed maternal anger (ADHD: OR = 0.62; 95% CI 0.38, 1.01; \( \chi^2 = 3.70; p = .0543 \); comparison: OR = 0.52; 95% CI 0.27, 0.99; \( \chi^2 = 3.91; p < .05 \)). In summary, child and maternal anger reports were clearly associated, but only in proximal intervals, and the patterns were similar for both groups.

Child Stress
Children with ADHD were over twice as likely to report stress during intervals proximal versus nonproximal to maternal anger (OR = 2.30; 95% CI 1.35, 3.88; \( \chi^2 = 9.65; p < .01 \)). The difference for comparison children was considerably smaller and did not reach statistical significance. Interestingly, despite this group difference, the overall rates of stress reported by the two groups

| Table III. Child Self-Reported Moods in the Context of Maternal Anger |
|-----------------------------|-----------------------------|-----------------------------|
| Child mood | Proximity to maternal anger | ADHD group (N = 51) | Comparison group (N = 58) |
| Mean proportion (N Obs.) |
|-----------------------------|-----------------------------|-----------------------------|
| Child anger | Nonproximal | 9.0 (239)^a | 7.0 (243)^a |
| Before | 10.4 (18)^b | 7.6 (13)^b |
| Proximal | 17.7 (97) | 16.2 (69)^b |
| After | 11.8 (17) | 9.2 (15) |
| Child stress | Nonproximal | 9.5 (252)^a | 14.9 (319) |
| Before | 13.3 (23) | 12.9 (22) |
| Proximal | 19.3 (106) | 18.5 (79) |
| After | 14.6 (21) | 12.9 (21) |
| Child good mood | Nonproximal | 77.6 (2067)^a | 85.3 (2977)^a |
| Before | 73.4 (127)^b | 84.2 (144) |
| Proximal* | 66.5 (365)^b | 78.2 (333) |
| After | 76.4 (110) | 83.4 (136) |

Significant within-group differences between temporal intervals:
^a nonproximal versus proximal.
^b before versus proximal.
^c proximal versus after.
^d nonproximal versus before.
^* ADHD versus comparison group difference, p < .05.
were quite similar during intervals proximal to and following maternal anger, as can be seen in Table III.

Child Good Mood
Like their mothers, children in both groups reported good moods the majority of the time. Both groups showed the expected decrease in rates of good moods in intervals proximal to maternal anger when compared with nonproximal intervals (ADHD: OR = 0.57; 95% CI 0.39, 0.83; $\chi^2 = 8.53; p < .01$; comparison: OR = 0.61; 95% CI 0.40, 0.92; $\chi^2 = 5.51; p < .05$). Turning to between-group analyses, children with ADHD reported lower rates of good moods than did their peers during proximal intervals (OR = 0.55; 95% CI 0.30, 1.00; $\chi^2 = 3.85; p < .05$), and this group difference reached a borderline level of significance during intervals before (OR = 0.52; 95% CI 0.26, 1.01; $\chi^2 = 3.73; p = .0534$) as well as those nonproximal to maternal anger (OR = 0.59; 95% CI 0.34, 1.01; $\chi^2 = 3.69; p = .0547$). In summary, the overall pattern supports Hypothesis 3: Differences between children with ADHD and comparison peers emerged in the positive (good mood) but not the negative (anger) affective domain.

Discussion
Mother–Child Mood Linkages Across Time in ADHD and Comparison Dyads
The primary goal of this study was to examine temporal links between child and maternal anger, as well as positive mood and perceived stress, in children with ADHD versus comparison peers. Cross-informant analyses revealed that, on an approximately half-hour basis, maternal moods varied with child anger in systematic ways. The converse was also true: Child moods varied systematically with maternal reports of anger, but there were fewer associations and group differences than when the focus was on maternal moods. The overall picture that emerges is one of comparable and systematic dyadic mood patterns in the ADHD and comparison groups, with a few notable differences.

Both groups of mothers reported anger more frequently in intervals before and after as well as in those proximal to child anger reports, suggesting a negative affective climate that extends beyond discrete child anger episodes. It may be especially noteworthy that following child anger, comparison mothers’ anger reports decreased substantially, even though the level remained somewhat elevated, whereas anger reports by mothers in the ADHD group showed little decline.

The findings for maternal good mood reaffirm the fact that positive and negative affect are not merely the inverse of each other. There were indications that child anger was negatively associated with maternal good mood to a more marked extent in the ADHD than the comparison group, and that this association seemed to persist only in the ADHD group. Taken together, these patterns suggest that mothers of children with ADHD may be especially reactive to their child’s anger and may not recover from child anger episodes as quickly or completely as do comparison mothers.

Based on this fine-grained assessment approach, the present findings replicate earlier documentation of elevated negative affect in mothers of children with ADHD (Johnston & Mash, 2001) and extend these findings by delineating context and timeline, suggesting that anger begets anger in a systematic fashion. Although any causal interpretations must be made cautiously, the interval-by-interval associations between child and maternal anger demonstrate that a negative affective climate is more likely to persist in ADHD than in comparison families. Any detrimental impact of negative parent and child moods seems likely to be exacerbated when, as in the present study, mothers also show a diminution of positive affect. The fact that elevated parental hostility has been linked to negative parenting practices and poor child outcomes (Jacobvitz et al., 2004) casts into sharp relief the clinical relevance of these findings.

It is intriguing to speculate about the extent to which the maternal mood findings that emerged in the present study reflect parent versus child factors. On the baseline questionnaires, mothers of children with ADHD reported more symptoms of ADHD and general psychopathology in themselves than did comparison mothers, as has been found in previous studies (e.g., Edwards et al., 2001; Johnston & Mash, 2001), although not always consistently (Gustafsson, Hansson, Eidevall, Thernlund, & Svedin, 2008). There is little basis, however, for assuming that maternal ADHD characteristics are associated with negative reactions toward a child with ADHD. In fact, Psychogiou, Daley, Thompson, and Sonuga-Barke (2008) reported that mothers with elevated ADHD symptoms were actually more rather than less positive and affectionate toward their children with ADHD than were mothers with few signs of ADHD. Apparently, the impact of maternal ADHD on parent–child relationships is not always unsalutary.

Previous studies have demonstrated that family functioning improves when children with ADHD receive pharmacotherapy (Gustafsson et al., 2008; Johnston & Mash,
All of the children with ADHD in this study were reported to be responding well to pharmacotherapy, yet some meaningful differences in affective climates between the two groups remained. These findings remind us that medication alone should not be expected to normalize the social worlds or family lives of children with ADHD, and that multimodal treatments are usually needed (Chronis, Jones, & Raggi, 2006).

**Children’s Self-Reports of Moods**

The most salient finding from the children’s reports is that mood profiles of children with ADHD were remarkably similar to those of their comparison peers. The associations between maternal anger and child moods were confined largely to intervals immediately proximal to maternal anger. In the within-group analyses, both groups reported more anger and less positive affect proximal than nonproximal to maternal anger, whereas for stress, this nonproximal-proximal difference emerged only for the ADHD group. It is also noteworthy that, in the between-group analyses, the only ADHD-comparison difference in child mood reports was a lower rate of good moods in children with ADHD during intervals proximal to maternal anger. This finding supports the hypothesis that children with ADHD may be more willing to report less of a positive characteristic than more of a negative one.

It may be useful to interpret the failure to find overall group differences in children’s self-reports of anger in the context of previous findings from a methylphenidate crossover study in which boys with ADHD who were taking placebo reported elevated anger levels compared with their self-ratings while medicated (Whalen & Henker, 1991). These findings seem pertinent here because the children with ADHD in the present study were receiving medication. It is impossible to know whether children with ADHD actually experience less anger when medicated, or whether they are more responsive to social norms in reporting their moods.

There is a vast literature documenting that children’s self-reports tend to show only modest correlations with information from other sources (De Los Reyes & Kazdin, 2005; Johnston & Murray, 2003). Discrepancies are the rule rather than the exception, and children’s reports are often considered less useful than those from adults who know them well. In a previous study using eDiaries with children and parents, we found fewer ADHD-comparison differences when we examined the children’s self-reports than when we examined mothers’ reports of their children’s behaviors and moods (Whalen, Henker, Jammer, et al., 2006). It is interesting to note that two other studies comparing parent and child reports of family functioning yielded similar discrepancies. Edwards et al. (2001) found that mothers and fathers of adolescents with ADHD, compared with parents of comparison teens, reported that their teens used more aggressive conflict tactics, whereas teen self-reports were not elevated in the ADHD group. Similarly, Gerdts et al. (2003) found that mothers and fathers of children with ADHD reported more negative perceptions of the parent–child relationship than did comparison parents, whereas the children’s perceptions of relationship quality did not differ. These findings may be attributable to a combination of child factors, including a lack of attention to social and emotional cues, metacognitive deficits in self-evaluation skills, or positive illusory biases. In the present study, we cannot determine whether the different rates of self-reported anger in mothers versus children are veridical, or whether they are attributable to child underreporting or maternal overreporting. Even though children’s reports may be less informative than those of their mothers, it is important to include the child’s perspectives because children have first-hand knowledge about their own moods, thoughts, and behaviors; they know things that cannot be observed by others. This study demonstrated that children can master the logistics and demands of eDiary assessments. The fact that maternal moods varied systematically in temporal relation to child self-reported anger also makes a compelling case for the meaningfulness of the children’s reports. It suggests that, even if children with ADHD underreport negative emotions such as anger, those instances that they do report are likely veridical. The cross-informant findings that emerged in this study attest to the promise of child-friendly eDiary monitoring in natural settings, in real time, as a means of obtaining unique and useful information about children’s moods and states.

**Using Experience Sampling with eDiaries to Map the Affective Terrain**

There is no doubt that eDiary approaches are uniquely suited to addressing a host of critical questions about moods and behaviors in dyadic context. The findings that emerged from this study could not have been gleaned from questionnaires or behavioral observations. Despite their documented advantages, it should be kept in mind that eDiaries carry their own methodological burdens. Any approach that entails frequent monitoring and requires several hours of parent–child contact per day may create selection artifacts. Families in chaotic and disorganized households are least likely to volunteer, and those with the busiest schedules may not have sufficient time together.
to participate. Although only two families dropped out after beginning the monitoring week because the mother could not tolerate the recording burden, other families were deemed ineligible because of time constraints, and we suspect that still other parents chose not to respond to informational flyers because of concerns that they or their children would not be able to handle the demands of recurrent recording.

Electronic diaries are also vulnerable to reactivity. Although the magnitude of reactivity apparently is quite small (Aaron, Turner, Mancl, Brister, & Sawchuk, 2005), the situation may change when diaries are completed by two individuals in proximity. Hearing a signal from the other person’s PDA may cue the child or parent to change behavioral course in order to prevent a negative assessment. Although one would expect that any self-consciousness habituates rapidly as recording becomes routine, we attempted to minimize potential reactivity by having mother and child diaries signal at slightly different times, as well as assuring both that their responses would not be shared.

Additional methodological limitations attend the compromises needed to make the eDiary procedures feasible in everyday life. Because we were concerned that responses would not be independent if the mother and child diaries prompted at the exact same time, and because we expected that children and mothers would complete their diaries at a different pace, the paired observations did not occur at precisely the same moment. It should also be kept in mind that reports were made every 30±6 min rather than continuously. Anger flare-ups can be both sudden and shortlived, and thus some of the temporal associations occurring in the real world may have been missed by this level of resolution. It is also the case that, within any 30-min interval, it is not possible to know whether the child’s anger preceded, followed, or coincided with the mother’s anger. Thus, inferences drawn about the affective recovery timelines of everyday life must be considered as tentative propositions for further empirical examination rather than as definitive conclusions.

Additional Limitations

There are additional limitations that should be considered when interpreting these findings. First, a host of third variables may have influenced the mood patterns that emerged, including the particular setting, activity, or social context (e.g., presence of the father or siblings). Second, the extent to which problematic interactions are attributable specifically to ADHD characteristics such as inattention and impulsivity or more generally to externalizing or oppositional problems cannot be determined. Nor could possible ADHD subtype differences be examined in this study, given the small number of children who met criteria for the predominantly inattentive subtype.

Some Directions for Future Research

Now that the feasibility and utility of eDiary approaches have been demonstrated, there are several intriguing directions for future research. One is to assess parent and child moods and behaviors when the child is taking medication versus placebo in order to map specific medication effects and, perhaps more important, noneffects. To increase our knowledge of behaviors-in-context, it would also be valuable to extend these studies to other natural environments such as classrooms and peer settings that might be considered “provocation ecologies” for children with ADHD. For both theoretical and clinical reasons, eDiaries from fathers, siblings, and perhaps even teachers and peers are needed in order to improve understanding of how roles, personal characteristics, and situational demands interact to exacerbate or ameliorate the problems of children with ADHD.

Additional future directions focus more explicitly on the potential for incorporating eDiaries into the therapeutic armamentarium. eDiaries are highly engaging for children. In individualized treatment programs, children can select and monitor target behaviors and then analyze their own diary data, in the process learning to respond to their own emotional cues, recognize situational triggers, and initiate preventive tactics. This type of approach could also encourage reflection and improve children’s self-evaluation skills. Analogously, showing parents their own data demonstrating that their anger reactivity appears to be more prolonged than does that of comparison mothers may prove useful when combined with therapeutic modules on family coercive processes, positive parenting, and emotion regulation. Future generations of eDiaries that we are now developing will combine assessment with treatment by using PDAs or smart phones to link self-reported moods and behaviors with a PDA-generated menu of specific therapeutic strategies designed to prevent or de-escalate problematic cycles. These new treatment directions will be attended by ethical challenges, especially the development of safeguards for protecting privacy and confidentiality among family members.

Conclusions and Implications

The findings that emerged from the present study emphasize the similarities between the ADHD and comparison groups in the affective give-and-take of everyday life. They also indicate, however, that problems in families of
children with ADHD endure even when these children are taking medications known to result in marked behavioral improvements. The salience of anger reactivity has direct implications for behavioral intervention programs. Indeed, many parents spontaneously commented on how much they learned during the study, suggesting that presenting families with summaries of their own diary data could be a powerful therapeutic tool. As the technology gains in sophistication, adaptability, and user-friendliness, and the costs continue to decline, it is becoming increasingly feasible to incorporate dyadic diary information from parents and children into tailored treatment programs for troubled families.

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