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# Emotional reactivity and regulation in anxious and nonanxious youth: a cell-phone ecological momentary assessment study

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**Background:** Reviews have highlighted anxious youths' affective disturbances, specifically, elevated negative emotions and reliance on ineffective emotion regulation strategies. However, no study has examined anxious youth's emotional reactivity and regulation in real-world contexts. **Methods:** This study utilized an ecological momentary assessment approach to compare real-world emotional experiences of 65 youth with generalized anxiety disorder, social anxiety disorder, or social phobia (ANX) and 65 age-matched healthy controls (CON), ages 9–13 years. **Results:** Hierarchical linear models revealed that ANX reported higher levels of average past-hour peak intensity of nervous, sad and upset emotions than CON youth but similar levels during momentary reports of current emotion. As expected, ANX youth reported more frequent physiological reactions in response to a negative event; however, there were no group differences in how frequently they used cognitive–behavioral strategies. Avoidance, distraction and problem solving were associated with the down-regulation of all negative emotions except nervousness for both ANX and CON youth; however, group differences emerged for acceptance, rumination and physiological responding. **Conclusions:** In real-world contexts, ANX youth do not report higher levels of momentary negative emotions but do report heightened negative emotions in response to challenging events. Moreover, ANX youth report no differences in how frequently they use adaptive regulatory strategies but are more likely to have physiological responses to challenging events. They are also less effective at using some strategies to down-regulate negative emotion than CON youth. **Keywords:** Ecological momentary assessment, experience sampling, anxiety, emotion regulation.

## Introduction

Difficulty regulating negative emotion is prominent in etiological models of pediatric and adult anxiety (Mennin, Holaway, Fresco, Moore, & Heimberg, 2007; Southam-Gerow & Kendall, 2002). Evidence of these difficulties is consistently reported among anxious adults (Amstadter, 2008). Nonetheless, despite strong interest in understanding the role of emotion regulation in anxiety, little is known about anxious youths' emotional experiences, including their reactions to naturally occurring negative events (Hannesdottir & Ollendick, 2007). Given anxiety interventions' emphasis on promoting cognitive–behavioral strategies, it is important to identify deficits in youths' in vivo regulatory efforts. That is, there is a need to determine (a) the degree to which anxious youth experience heightened negative emotion in real-world contexts and (b) whether youth are able to effectively use cognitive–behavioral strategies to down-regulate negative emotional reactions to real-world challenges.

### *Pediatric anxiety and emotion regulation*

Much of the supporting evidence for relations between emotion regulation deficits and anxiety comes from work with adults. Specifically, studies of adults who show elevated or clinical levels of anxious symptoms suggest associations between anxiety and disrupted emotional processes, such as (a) heightened negative emotional reactivity, (b) lower levels of emotional understanding, (c) frequent use of avoidant coping behaviors, and (d) difficulty accessing effective emotion regulation strategies (e.g. Salters-Pedneault, Roemer, Tull, Rucker, & Mennin, 2006). Results from the few empirical studies of emotion regulation in anxious youth are generally consistent with adult research. In one of the first studies characterizing anxious youths' emotion regulation, Suveg and Zeman (2004) found that, in response to hypothetical vignettes, anxious youth report more intense negative emotions, less adaptive emotion regulation strategies (e.g. rumination, avoidance) and lower levels of perceived efficacy at regulating distress than healthy peers. Other studies have also demonstrated relations between anxiety and increased experiences of negative emotion, albeit in children with elevated anxious traits rather than anxiety disorders (Henker, Whalen, Jamner, & Delfino, 2002). There is also some evidence that anxious youth report a greater reliance on maladaptive emotion regulation strategies (i.e. strategies such as rumination that increase

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symptomatology) than healthy peers (Carthy, Horesh, Apter, Edge, & Gross, 2010; Suveg & Zeman, 2004).

Yet, because youths' emotion regulation was assessed with questionnaires of *general* regulatory ability, it remains unclear if (a) anxious youth indeed lack adaptive strategies, (b) *purportedly* adaptive strategies are ineffective for down-regulating their nervous affect, and/or (c) anxious youth merely *perceive* themselves as less efficacious. Research has consistently demonstrated that anxious youth believe themselves to be less effective at down-regulating negative emotions (e.g. Kortlander, Kendall, & Panichelli-Mindel, 1997); however, few studies have examined the validity of this belief by examining anxious youths' in vivo attempts at regulating real-world negative events.

The transition to adolescence is associated with heightened emotionality and increased diversity of social experiences (e.g. Larson, Raffaelli, Richards, Ham, & Jewell, 1990). It may therefore be especially important to study how youth in this age range regulate negative emotion in real-world contexts. Given the negative sequelae of pediatric anxiety, identification of factors (e.g. emotion regulation difficulties) that sustain or exacerbate symptoms could not only enhance the successful treatment of anxiety but also prevent the development of depression, substance abuse, and adult mood disorders (e.g. Woodward & Fergusson, 2001).

In sum, based largely on evidence from laboratory assessments and hypothetical vignettes, etiological models suggest that anxious youths' vulnerability for elevated negative emotion impairs their ability to effectively engage cognitive–behavioral strategies, thereby maintaining or worsening symptomatology (Hannesdottir & Ollendick, 2007). Although invaluable in providing preliminary evidence for the role of emotion regulation in anxiety, these approaches limit understanding of whether laboratory-based or questionnaire reports of heightened negative emotions and maladaptive strategy use generalize to youths' real-world emotional experiences.

### *Advantages of ecological momentary assessment methods for studying affective functioning*

A common approach for assessing youths' emotional reactivity and regulation is through retrospective reports, but this methodology has various limitations, including response biases (i.e. the tendency to recall the most intense and recent experiences) and the inability to capture in vivo or 'online' cognitions (e.g. Stone et al., 1998). An ecological momentary assessment (EMA) approach addresses many of these limitations by assessing emotions as they occur in individuals' natural environments. EMA is a method for obtaining ecologically valid and representative data on youths' emotional processes (Stone et al., 1998). EMA has furthered understanding of emotional reactivity and regulation in nonclinical (Larson et al., 1990) and clinical (Silk et al., 2011) samples of youth. To our knowledge, only one study has used EMA to examine relations between emotional processes and anxious symptomatology. Henker et al. (2002) found that higher levels of anxious symptomatology were associated with higher levels of negative emotion among a nonclinical sample of adolescents.

The present study is the first to use EMA to investigate the emotional reactivity and regulation of clinically anxious youth transitioning to adolescence. Because EMA provides detailed information about the intensity and timing of youths' negative emotions, researchers can investigate the effectiveness of their emotion regulation strategies. That is, the regulatory influence of a particular strategy can be inferred by examining relations between the use of a particular strategy in response to a negative event in the past-hour and youths' current level of negative emotion (Silk, Steinberg, & Morris, 2003).

Using a new cellular phone EMA methodology (Silk et al., 2011) the study investigated group differences in the real-world emotional reactivity and regulation of anxious youth and age-matched healthy controls. Given the prominence of negative emotion in etiological models of anxiety, evidence of increased negative emotionality in adolescence, and emphasis on the down-regulation of negative emotion in anxiety interventions, the study is limited to youth's experience of negative emotion. Specifically, we hypothesized that anxious youth would experience higher levels of anger, sadness, nervousness and upset affect than healthy controls. Studies suggest that anxious youth exhibit lower levels of emotion understanding or awareness (e.g. Suveg & Zeman, 2004), thus, a nonspecific term such as 'upset' may be important to include in assessments of generalized distress. We also predicted that anxious youth would report decreased use of adaptive emotion regulation strategies (i.e. problem solving, distraction), greater use of maladaptive strategies (i.e. rumination, avoidance), and greater physiological arousal in response to negative events than age-matched healthy controls. Finally, we expected that all strategies would be less effective at down-regulating negative emotions for anxious youth than healthy controls.

## Method

### *Procedures*

Data comes from two larger studies, a treatment study of pediatric anxiety and a normative study of socio-emotional functioning. Youth from the treatment study were recruited from three sources: community advertisements; psychiatric clinics at a major medical

center; and referrals from other research studies or already-enrolled participants. Eligible youth met DSM–IV criteria for a primary diagnosis of generalized anxiety disorder ($N = 43$), separation anxiety disorder ($N = 12$), or social phobia ($N = 10$). Of the anxious youth, 28 met criteria for multiple anxiety disorders, and 7 had comorbid disorders, enuresis ($N = 4$) or attention-deficit hyperactivity disorder, inattentive type ($N = 3$). Youth with a primary diagnosis of major depression (MDD) were excluded; the study included one youth who was in partial remission and a second who was diagnosed with secondary MDD. Exclusionary criteria also included developmental delays, specific learning disabilities, ongoing treatment with psychoactive medications, comorbid diagnoses of obsessive-compulsive, posttraumatic stress, or conduct disorders, substance abuse or dependence, and lifetime diagnoses of autism spectrum, bipolar, psychotic, schizophrenia, or schizoaffective disorders. Youth were also excluded if they had previously completed a course of cognitive–behavioral therapy. Qualifying youth underwent a multifaceted protocol that included: a 16-session randomized cognitive–behavioral treatment ($N = 42$) or a comparison child-centered supportive therapy ($N = 23$) protocol and an EMA protocol for assessing youths' naturally occurring emotions and regulatory strategies, collected in five 4-day blocks during the study. The present study uses EMA data during the 5-day baseline assessment, prior to treatment commencement.

Youth from the normative study ranged from ages 9 to 13 years and were recruited in a similar fashion as the treatment study, with the exception of referrals from psychiatric clinics. Youth had no Axis 1 psychiatric disorders or developmental delays. Qualifying youth completed a parallel EMA protocol assessing naturally occurring emotional responses, collected in three 5-day blocks. The present study includes only EMA data from the 5-day baseline assessment to remain comparable with data for anxious youth. All study procedures were approved by the university's Institutional Review Board.

The final sample included 130 youth, 65 anxious (ANX) and 65 age-matched healthy controls (CON) who completed the first (baseline) week of the EMA protocol. The mean age of the ANX sample was 10.90 years ($SD = 1.43$). The CON sample had a mean age of 10.41 years ($SD = 1.30$ years). As expected, the ANX group reported higher levels of anxiety on the Screen for Child Anxiety-related Emotional Disorders (Birmaher et al., 1997) than the CON group, $F(1, 114) = 139.68$; $M_{ANX} = 38.70$; $M_{CON} = 13.60$. There were no significant diagnostic group differences in gender ($F_{ANX} = 38$; $F_{CON} = 32$), age ($M_{ANX} = 10.90$, $SD_{ANX} = 1.43$; $M_{CON} = 10.41$, $SD_{CON} = 1.30$), or maternal education. In the ANX sample, 12.3% of mothers had a high school education, 61.4% completed or received some college education and 26.3% obtained postgraduate training. In the CON sample, 16.4% of mothers had a high school education, 60% completed or received some college education and 23.6% obtained postgraduate training. However, youth in the CON group were more likely to be European American than in the ANX group ($\chi^2 = 4.34$, $p < .05$) thus race was included as a covariate in analyses.

### Instruments

*Structured diagnostic interviews.* For anxious youth, each child and parent(s) were interviewed to determine the youths' psychiatric history using the Schedule for Affective Disorders and Schizophrenia in School-Age Children – Present and Lifetime version (K-SADS–PL; Kaufman, Birmaher, Brent, & Rao, 1997). Parents and youth were interviewed separately, with interviewers integrating data from both informants to arrive at a final diagnosis. All interviews were carried out by trained BA- and MA-level research clinicians. Interview results were presented at a consensus case conference with a child psychiatrist, who reviewed the preliminary diagnosis and provided a final diagnosis based on DSM–IV criteria (American Association for Psychiatry, 1994). To screen for Axis 1 psychiatric disorders in the normative youth sample, parents completed a child psychiatric screening inventory, the Adolescent Symptom Inventory 4 if children were over age 12 years (Gadow & Sprafkin, 1998a), and the Child Symptom Inventory 4 (Gadow & Sprafkin, 1998b) if they were under age 12. Both inventories inquire about child behavior in over 17 categories related to DSM–IV (APA, 1994) diagnostic categories. When screening indicated that a DSM–IV disorder might be present, the relevant module of the K-SADS was administered as described above to finalize decisions about diagnostic eligibility.

### Ecological momentary assessment

Through pilot testing (Axelson et al., 2003), we developed a cellular phone methodology for collecting EMA data on youths' real-world emotional processes. This methodology allowed us to maximize accuracy by allowing for probes for unclear responses and limiting writing demands for younger and symptomatic participants. EMA procedures were identical across the two studies.

Before obtaining answer-only cellular phones on which they received calls from a trained interviewer, youths underwent an orientation session where they were familiarized with the phone and interview questions. This session also allowed researchers to gauge youths' understanding of the questions and youths to seek clarification on confusing items. The sampling period occurred from Thursday after school through the following Monday evening, allowing us to sample time intervals when behavioral choice are most variable (e.g. weekends) as well as behavior within the structure of the school schedule. It includes Sunday night when youth may worry about school the next day. Youth were called twice between the hours of 4 p.m. and 9:30 p.m. on weekdays (Thursday, Friday and Monday) and four times between the times of 11 a.m. and 9:30 p.m. on Saturday and Sunday, totaling 14 calls or sampling events. If a youth did not answer on the first attempt, the call was made again after 10 min. If a youth was awakened by the call, he or she was offered a few minutes to wake up and were then called again. Information from EMA calls was not shared with parents or therapists unless safety concerns arose.

Each call consisted of a brief structured interview adapted from Silk et al. (2003, 2011). The interview was

brief, approximately 5 min long, and included assessments of youths' momentary affect and emotional and behavioral responses (i.e. emotion regulation strategies) to a negative emotional event that occurred in the past hour. As demonstrated in previous research (e.g. Silk et al., 2003), a window of 1 hr maximizes the chances of assessing naturally occurring emotional experiences while minimizing biases of retrospective recall. Although youth were not expected to experience a significant negative emotional event in every 1-hr sampling interval, they were requested to identify a negative experience during each call, even if it was a minor event.

*Momentary emotion ratings.* At each call, youth were asked to rate their *current* emotion on a subset of 5-point scales adapted from the Positive and Negative Affect Schedule for Children, ranging from (1) *very slightly or not at all* to (5) *extremely* (Laurent et al., 1999). The current study focused on youths' ratings of negative emotions, specifically, 'sad', 'angry', 'nervous' and 'upset'.

### Peak negative emotion ratings and emotion regulation strategies

*Peak emotion ratings.* Youth were also asked to rate their emotional responses (i.e. peak levels of sad, angry, nervous and upset affect) to a self-nominated negative event that occurred within the past hour. Youth also estimated the time at which the negative event occurred in 15-min intervals, ranging from (1) *right before the call* to (5) *about 1 hr ago*.

*Emotion regulation strategies.* After rating their peak negative emotions, youth reported their responses to the same event using the following six categories of cognitive–behavioral strategies commonly identified in emotion regulation literature: distraction, cognitive restructuring, problem solving, acceptance, avoidance and rumination (Connor-Smith, Compas, Wadsworth, Thomsen, & Saltzman, 2000; Silk et al., 2003). Specifically, for each negative event, youth were asked whether they engaged in each of the six different strategies; youth could report multiple strategies. Based on pilot data and previous research (e.g. Axelson et al., 2003), the strategies were described in child-friendly, nontechnical terms during the orientation session (see Appendix S1). For example, to query youths' use of cognitive restructuring, interviewers asked if youth 'told themselves it wasn't a big deal or tried to think of the problem in a different way so it didn't seem as bad' in response to the negative event. Second, it can be difficult to distinguish between different strategies, in particular, avoidance and distraction. In the present study, distraction was defined by engagement in *another activity* (i.e. 'Did you keep mind off the problem by doing something else? What did you do?'), whereas avoidance was defined by *disengagement*, specifically, 'not thinking' or 'forgetting all about the problem'. Moreover, because trained interviewers conducted each call, youth were able to clarify any confusion regarding the descriptions of each strategy. Finally, somatic responses indicative of physiological arousal (e.g. sweating, fast heart rate) were separately classified as physiological responses.

Youths' physiological responses and emotion regulation strategies were examined only for sampling events containing a peak negative affect rating ≥ 3 on any of the negative emotions (ANX = 76.5%, CON = 75.7% of events). This threshold was chosen to ensure that youth were responding to events that were at least moderately distressing, and consequently, necessitating emotion regulation.

The number of different cognitive–behavioral strategies a youth endorsed across the 14 calls was summed, creating a measure of strategy range or a youths' repertoire of cognitive–behavioral strategies. Next, dichotomous variables indicating the presence or absence of each of the six regulatory strategies and physiological responses were created for the negative events in which youth reported a peak negative emotion at an intensity ≥ 3. Dichotomous variables were then used to create ratios indexing the proportion of negative events in which youth used a specific cognitive–behavioral strategy or experienced physiological arousal.

### Data analytic plan

Multivariate analyses of variance, with diagnostic group as a between-subjects effect, were used to test for group differences in youths' range and frequency of cognitive–behavioral strategies; child race was included as a covariate. Between-group differences in ANX and CON youths' negative emotions and effectiveness of emotion regulation strategies were examined using linear mixed-effects models to account for the nesting of assessments within subjects (Hedeker & Gibbons, 2006). All models included a random intercept, subject as a random effect, and sampling event as a repeated measure. Child diagnostic group was included as a fixed effect and child race was included as a covariate. Models examining group differences in negative emotion included anger, sad, upset or nervous as a fixed effect. Models examining the effectiveness of a regulatory behavior included strategy (e.g. avoidance) or physiological arousal as a fixed effect and peak negative emotion (e.g. anger) and time since negative event as covariates. Interactions between diagnostic status and regulatory strategy were tested for all behaviors and significant interaction effects were probed using post hoc least significant difference tests of marginal means; however, only significant interactions are reported. Finally, time of call (i.e. afternoon or evening) was included as a covariate. Morning was not tested because all calls started after 11 a.m. (only 4.6% of call occurred before 12 p.m.). Because time of call was nonsignificant in any model examining group differences in emotion or regulatory behavior ($F$'s ranging from 0.07 to 1.30), we excluded from the final models reported in the present study (see Appendix S2).

## Results

### Preliminary analyses

On average, anxious youth completed 13.02/14 (93%) possible calls and healthy controls completed 12.79/14 (91.3%). Compliance rates did not significantly differ between groups and were comparable or superior to compliance reported in EMA studies

using alternative methodologies (Csikszentmihalyi & Larson, 1992).

### *Momentary emotion*

Aggregate means and standard deviations of youths' affective functioning across the sampling period are presented in Table 1. Contrary to expectations, results from mixed-effects models revealed *no* significant differences in ANX and CON youths' momentary emotional experiences. There was a marginal group difference in youths' experience of nervousness, $F(1, 129.92) = 3.54$, $p < .07$, with ANX youth reporting higher levels of nervousness than CON youth during EMA calls.

### *Peak emotional responses to negative event*

When asked about their emotional reactions to a negative event in the past hour, diagnostic group differences were apparent for almost all peak negative emotions. Specifically, anxious youth reported experiencing more intense peak levels of nervous, $F(1, 129.71) = 5.71$, $p < .02$, sad, $F(1, 129.27) = 4.29$, $p < .05$, and upset affect, $F(1, 129.93) = 4.80$, $p < .05$, than nonanxious youth.

### *Range and frequency of emotion regulation strategies*

There were no group differences in youths' range of regulatory strategies. In addition, there were few group differences in how frequently ANX and CON youth used different emotion regulation strategies; however, ANX youth reported more frequent physiological reactions in response to negative events ($t = -2.08$, $p < .05$) than CON youth.

**Table 1** Aggregate emotion and behavior ratings by diagnostic group (ANX, anxious; CON, control)

| | ANX | CON |
|---|---|---|
| Intensity of current emotion | | |
| Angry | 1.22 (0.32) | 1.23 (0.29) |
| Sad | 1.34 (0.44) | 1.33 (0.39) |
| Upset | 1.32 (0.40) | 1.29 (0.30) |
| Nervous | 1.63 (0.71) | 1.39 (0.44) |
| Intensity of peak emotion | | |
| Angry | 2.72 (0.80) | 2.55 (0.72) |
| Sad | 2.28 (0.72) | 2.01 (0.70) |
| Upset | 2.69 (0.80) | 2.40 (0.73) |
| Nervous | 1.78 (0.72) | 1.51 (0.52) |
| Range of strategies | 3.56 (1.09) | 3.50 (1.19) |
| Frequency of strategy use (% of negative events) | | |
| Distraction | 50% (24%) | 46% (27%) |
| Cognitive restructuring | 68% (27%) | 72% (29%) |
| Problem solving | 42% (24%) | 41% (28%) |
| Acceptance | 73% (27%) | 80% (30%) |
| Avoidance | 72% (28%) | 72% (32%) |
| Rumination | 39% (31%) | 33% (32%) |
| Physiological responding | 12% (17%) | 5% (10%) |

Values are shown as mean (*SD*).

### *Effectiveness of emotion regulation strategies*

Table 2 summarizes results from mixed-effects models examining whether emotion regulation strategies were associated with the down-regulation of youths' anger, sad and upset affect, respectively. Effectiveness was inferred by examining predictive relations between youths' cognitive–behavioral responses to a negative event in the past hour and the intensity of their momentary negative emotions during the same sampling event, controlling for peak negative emotion in the past hour and time elapsed since event occurrence (see Silk et al., 2003). Interactions between diagnostic status and strategy use were tested for each strategy; however, nonsignificant interactions were streamlined. Thus, the final models presented in Table 2 report only significant interactions.

*Problem solving.* As expected, after controlling for time since occurrence of a negative event and peak intensity of angry affect, problem solving was a significant predictor of youths' momentary anger intensity. Specifically, youth reported lower levels of momentary anger following a negative event when they engaged in problem solving than when they did not. Similarly, youth reported lower levels of momentary upset affect following the use of problem solving than not. Contrary to expectations, however, diagnostic status did not moderate the influence of problem solving on anger or upset affect. Problem solving did not significantly predict changes in youths' sadness or nervousness.

*Cognitive restructuring.* Youths' use of cognitive restructuring predicted lower levels of upset but showed no relations with any other negative emotion. That is, youth reported lower upset levels following a negative event when they responded with cognitive restructuring than when they did not. Cognitive restructuring did not influence any other negative emotions; nor did group differences emerge between ANX and CON youth.

*Distraction.* As expected, use of distraction predicted lower levels of anger and sadness in ANX and CON youth than no use of distraction (see Table 2). In addition, diagnostic status moderated the relations between distraction and upset affect. Specifically, among ANX youth, use of distraction is associated with *lower* levels of upset than no use of distraction, $F(1, 890) = 5.37$, $p < .05$; $M_{\text{Upset(distract)}} = 1.20$, $M_{\text{Upset(no distract)}} = 1.38$. Thus, distraction is associated with the down-regulation of upset affect only among ANX youth. Finally, distraction has no association with youths' current nervous affect.

*Acceptance.* Contrary to expectations, use of acceptance did *not* significantly predict youths'

**Table 2** Fixed effects for mixed-effects models of strategy effectiveness

| | *F* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Problem solving | | | | Cognitive restructuring | | | |
| | Angry | Sad | Upset | Nervous | Angry | Sad | Upset | Nervous |
| Model fit | | | | | | | | |
| AICC | 1,764.7 | 1,855.0 | 1,931.8 | 2,116.1 | 1,771.1 | 1,855.2 | 1,944.4 | 2,114.9 |
| BIC | 1,792.6 | 1,915.7 | 1,959.6 | 2,144.0 | 1,801.7 | 1,918.7 | 1,975.1 | 2,142.8 |
| Race | 1.47 | 0.58 | 0.44 | 0.01 | 1.57 | 0.54 | 0.55 | 0.00 |
| Peak negative emotion | 25.98*** | 38.84*** | 24.73*** | 41.92*** | 25.98*** | 33.42*** | 27.29*** | 42.13*** |
| Time since negative event | 12.33*** | 4.27* | 1.27 | 0.03 | 13.02*** | 4.15* | 1.61 | 0.03 |
| Diagnostic group | 0.59 | 0.66 | 0.04 | 3.03 | 0.25 | 0.68 | 0.00 | 2.94 |
| Strategy use | 9.68*** | 0.71 | 20.18*** | 1.08 | 2.64 | 1.28 | 4.62** | 1.05 |
| | Distraction | | | | Acceptance | | | |
| Model fit | | | | | | | | |
| AICC | 1,762.5 | 1,851.8 | 1,940.9 | 2,117.2 | 1,774.4 | 1,854.7 | 1,951.2 | 2,114.3 |
| BIC | 1,790.3 | 1,912.6 | 1,968.8 | 2,145.1 | 1,805.1 | 1,918.1 | 1,981.8 | 2,142.1 |
| Race | 2.24 | 0.74 | 1.02 | 0.00 | 1.91 | 0.64 | 0.83 | 0.00 |
| Peak negative emotion | 28.08*** | 3.60* | 25.63*** | 40.81*** | 27.26*** | 34.47*** | 27.04*** | 42.36*** |
| Time since negative event | 11.35*** | 31.41*** | 0.97 | 0.03 | 12.24*** | 3.92* | 1.26 | 0.04 |
| Diagnostic group | 0.17 | 0.55 | 0.02 | 2.96 | 0.59 | 0.90 | 0.00 | 3.15† |
| Strategy use | 11.94*** | 3.91* | 10.80***[a] | 0.01 | 0.96 | 1.67 | 1.23[b] | 1.63 |
| | Avoidance | | | | Rumination | | | |
| Model fit | | | | | | | | |
| AICC | 1,766.7 | 1,841.4 | 1,938.2 | 2,113.9 | 1,775.6 | 1,857.5 | 1,950.7 | 2,112.7 |
| BIC | 1,797.3 | 1,908.1 | 1,968.9 | 2,141.8 | 1,806.2 | 1,920.9 | 1,981.3 | 2,140.6 |
| Race | 1.93 | 0.55 | 0.84 | 0.00 | 1.90 | 0.62 | 0.79 | 0.01 |
| Peak negative emotion | 27.83*** | 33.82*** | 28.75*** | 40.58*** | 26.64*** | 32.59*** | 1.48[b] | 38.92*** |
| Time since negative event | 13.35*** | 4.20* | 1.72 | 0.05 | 12.81*** | 4.44* | 1.64 | 0.18 |
| Diagnostic group | 0.22 | 0.71 | 0.00 | 2.96 | 0.22 | 0.71 | 0.01 | 2.86 |
| Strategy use | 4.86*** | 5.62* | 7.82*** | 0.75 | 0.39 | 0.13 | 1.64[b] | 3.20† |
| | Physiological responses | | | | | | | |
| Model fit | | | | | | | | |
| AICC | 1,774.3 | 2,115.8 | 1,943.4 | 2,110.1 | | | | |
| BIC | 1,804.9 | 2,146.5 | 1,374.1 | 2,138.0 | | | | |
| Race | 1.98 | 0.58 | 0.50 | 0.01 | | | | |
| Peak negative emotion | 26.66*** | 25.63*** | 25.74*** | 35.14*** | | | | |
| Time since negative event | 12.22*** | 1.18 | 1.12 | 0.02 | | | | |
| Diagnostic group | 0.35 | 0.35 | 0.15 | 2.55 | | | | |
| Strategy use | 1.03 | 0.58 | 3.86* | 3.37† | | | | |

[a]Main effect is qualified by an interaction. [b]Strategy use × Diagnositc group interaction is significant and improves model fit.
†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

angry, sad or nervous affect following an emotional challenge. However, a three-way Group × Acceptance × Peakupset interaction, $F(1, 885) = 10.04$, $p < .001$, emerged for youths' upset affect (Figure 1). Specifically, the use of acceptance was associated with lower levels of upset emotion among CON youth but only in response to emotional events perceived as highly (+1 *SD*) negative. In contrast, the use of acceptance was unassociated with ANX youths' upset affect in reaction to highly (+1 *SD*) or moderately (−1 *SD*) negative events.

*Avoidance.* Avoidance following a negative event was an unexpected significant predictor of youths' current levels of angry, sad and upset affect. That is, both ANX and CON youth reported lower levels of negative emotion when avoidance was used than when it was not. Avoidance did not predict youths' current nervousness nor did diagnostic status moderate relations between avoidance and any negative emotion.

*Rumination.* There were no significant main effects for rumination in predicting upset affect; however, a significant interaction between diagnostic status and rumination emerged. As expected, use of rumination predicted higher levels of upset affect following a negative event but *only among* ANX youth. Specifically, whereas use of rumination did not predict CON youths' upset affect following an emotional challenge, it predicted *higher* levels of upset in ANX youth, $F(1, 844) = 5.91$, $p < .01$; $M_{\text{Upset(ruminate)}} = 1.41$, $M_{\text{Upset(no ruminate)}} = 1.20$. Rumination was not a significant predictor

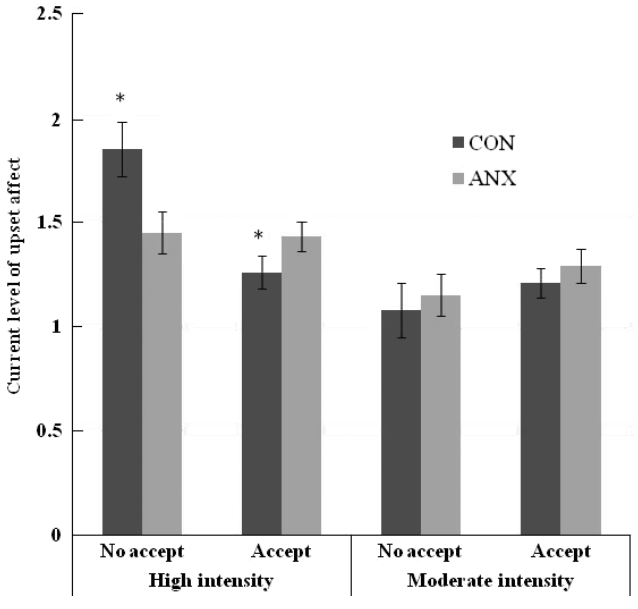


**Figure 1** Effectiveness of acceptance in the down-regulation of upset affect in highly versus moderately negative events

of angry, sad or nervous affect in ANX or CON youth.

*Physiological responses.* As expected, physiological responses to a negative event were predictive of higher subsequent levels of upset. However, surprisingly, physiological responses were not predictive of any other negative emotion and diagnostic status did not moderate relations between physiological responding and current levels of upset.

## Discussion

Few studies have examined clinically anxious youths' affective functioning (but see Suveg & Zeman, 2004; Carthy, Horesh, Apter, Edge, et al., 2010; Carthy, Horesh, Apter, & Gross, 2010) and none have examined youths' in vivo experiences of negative emotion or regulatory behaviors. With a new cell-phone EMA methodology, the current study examined the momentary reports of anxious youths' emotions and regulatory responses to naturally occurring negative events. Consistent with models highlighting the role of emotional reactivity in anxiety, we found that anxious youth reported more intense *peak* negative emotions than age-matched controls. However, contrary to previous questionnaire or laboratory-based studies that rely on retrospective recall of general or daily emotional experiences, anxious and nonanxious youth did not differ in their reports of momentary negative emotions. Through EMA methodology, these surprising findings suggest that anxious youth do not experience more frequent or intense momentary negative emotions during everyday experiences in real-world contexts.

One possible explanation for results suggesting that anxious youth report higher peak, but not momentary, experiences of negative emotion is that anxious youth experience shorter-lived negative emotions, perhaps, perhaps because they are more effective at regulating emotion. However, examination of the effectiveness of specific cognitive–behavioral strategies suggests that when group differences emerged, nonanxious youth were able to effectively use cognitive–behavioral strategies to down-regulate negative emotion but anxious youth were not. As such, group differences in anxious and nonanxious youths' peak negative emotions may stem, in part, from anxious youths' bias for negative information. This bias has been frequently documented in studies of anxious youths' attentional control and information processing and may heighten anxious youths' reactivity to everyday negative events (Hadwin & Field, 2010).

Anxious youths' more intense emotional reactions to negative events may also stem from differences in physiological responding. Specifically, when confronted with a challenging situation, anxious youth reported not only higher levels of negative emotion but also more frequent physiological responses than nonanxious youth. These findings are a possible indication of anxious youths' heightened emotional reactivity and are also consistent with well-established research on anxiety sensitivity as a risk factor for anxiety. Anxiety sensitivity, defined as the fear of anxiety and anxiety-related sensations, heightens perceptions of physiological arousal, increasing anxious youths' level of emotional distress. The resulting amplification of distress is reflected in anxious youths' reports of more frequent physiological responses and intense negative emotions (e.g. Kashdan, Zvolensky, & McLeish, 2008). That is, negative events may be more salient to anxious youth, in part, because they are more physiologically reactive during negative events than nonanxious youth. Moreover, these frequent experiences of increased physiological arousal may heighten their anxiety-sensitivity and, consequently, avoidance of any potentially challenging events. Our understanding of the development and maintenance of pediatric anxiety would therefore benefit from understanding the influence of anxiety sensitivity on youths' use of avoidance versus more adaptive regulatory strategies (i.e. cognitive restructuring) and subsequent emotional reactivity when coping with negative emotions.

Anxious youth did not show differences in the range or frequency of their emotion regulation strategies. Using EMA methodology capable of in vivo assessment of youths' naturally occurring regulatory attempts, results reveal that, with the exception of physiological responding, anxious youth do not show greater reliance on maladaptive strategies (i.e. avoidance, rumination) or less reliance on adaptive strategies (i.e. acceptance, problem solving).

However, despite similar rates of strategy use, the regulatory effect of certain strategies differed between anxious and nonanxious youth.

By capitalizing on EMA's capacity to capture changes in youths' intensity of negative emotions following the use of regulatory strategies, we examined the effectiveness of youths' cognitive–behavioral strategies for down-regulating negative emotion. Problem solving and distraction were effective strategies for down-regulating anger and sadness among all youth. However, the effects of rumination on subsequent emotion were more detrimental for anxious than nonanxious youth. The detrimental effects of rumination for anxious youth remained significant even after removing the two subjects with comorbid depression, suggesting that rumination may also serve as a risk factor for anxiety. Furthermore, when applied to highly upsetting events, acceptance was less effective in down-regulating negative emotion for anxious than nonanxious youth. Overall, these results suggest that anxious youth may have difficulty tolerating the physiological arousal that accompanies increased negative emotion because they ruminate on the somatic symptoms and/or have difficulty accepting negative emotions and environmental circumstances. It would be interesting to examine whether anxious and depressed children differ in the content of their ruminations and whether rumination is a risk factor for the development of comorbid depression and anxiety.

Laboratory-based research highlights the effectiveness of cognitive restructuring in anxious youth (Carthy, Horesh, Apter, Edge et al., 2010); however, we found inconsistent evidence that anxious or nonanxious youth were able to effectively use cognitive restructuring. That is, EMA methods that youths' *spontaneous* use of cognitive restructuring had little regulatory influence on any real-world negative responses to a challenging event, with the exception of upset affect. Studies investigating individual differences in emotion regulation therefore should examine how instructed strategy use in laboratory contexts differs from spontaneous use. In addition, developmental differences in the effectiveness of different strategy types are understudied, leaving questions regarding the importance and feasibility of coaching youth to use cognitive regulatory strategies unanswered.

The effect of diagnostic status on the effectiveness of acceptance may be particularly important for improving pediatric anxiety interventions. Because acceptance and acceptance-based strategies are thought to be central to adaptive emotion regulation in situations that are difficult to change or control, it seems critical for anxious youth to improve their ability to use acceptance if they are to successfully manage emotions across varied challenges. Moreover, research indicates that anxious youth struggle particularly with emotion regulation in situations in which they perceive little control (Southram-Gerow & Kendall, 2002). Anxious youths' difficulties effectively utilizing acceptance may play a role in understanding their physiological hyperactivity in such situations. Thus, the effectiveness of pediatric anxiety interventions may improve with specific focus on strengthening anxious youths' ability to effectively use acceptance and identify situations where acceptance would likely be a preferred strategy. Finally, studies delineating developmental considerations in teaching youth abstract cognitive skills like acceptance or cognitive restructuring are needed. The benefits of acceptance-based therapies appear promising in adult populations (Hayes, Luoma, Bond, Masuda, & Lillis, 2006) but specific recommendations for how to effectively teach such strategies to children at different developmental levels are still lacking.

Contrary to models of effective anxiety regulation (e.g. Suveg, Kendall, Comer, & Robin, 2006), avoidance was an effective regulatory strategy for all negative emotions except nervousness. This unexpected finding highlights a limitation in most emotion regulation studies, that is, little consideration of differences in the long-term versus short-term health consequences associated with a regulatory behavior. Although effective for reducing negative emotions in the short-term, avoidance probably leads to heightened negative emotionality in the long term, particularly if it inflexibly deployed in response to all challenges. Future studies should examine the time course of effectiveness for different strategies and identify patterns of avoidance use that portend maladjustment.

Finally, it is notable that no strategies were effective for down-regulating nervous affect, even among nonanxious youth. This is consistent with literature across childhood and adolescent demonstrating greater effectiveness in down-regulating anger and sadness than nervousness (Buss & Goldsmith, 1998; Silk et al., 2003). This highlights the importance of examining regulatory strategies in context of specific negative emotions.

This study has several limitations. First, data were limited to 1 week of sampling events. Nonetheless, this is the first study to examine the emotion regulation strategies of clinically anxious youth coping with naturally occurring negative events in real-world contexts. Second, youth reported on *all* their behavioral responses to a negative event. Thus, the effectiveness of each behavior could be moderated by the presence of other strategies or the presence of physiological responding. Given our sample size, we were not able to test interactions among all the coping behaviors. However, because little is known about the effectiveness of youths' emotion regulation strategies, it was important to first establish an understanding of the effectiveness with which a particular strategy is deployed in anxious versus nonanxious youth. Furthermore, as one of the first studies to examine the effectiveness of different

cognitive–behavioral strategies for down-regulating specific types of negative emotion, we explored a number of hypotheses. Thus, replication of our findings will be important for our understanding of how anxiety influences youths' emotion regulation ability. Finally, there were relatively few ethnic minorities in either the anxious or healthy-control sample, limiting generalizability of the present findings.

Best practice guidelines for pediatric anxiety emphasize the promotion of cognitive–behavioral strategies. Furthermore, etiological models highlight the role of emotion regulation difficulties in the development and maintenance of anxiety. Current findings suggest that the effectiveness of cognitive–behavioral interventions for pediatric anxiety may be enhanced by greater emphasis on coaching anxious youth to use abstract, cognitively based strategies for regulating negative emotion and dampening physiological arousal, in particular, the contexts in which these strategies could be most effective (Cheng, 2001).

## Supporting information

Additional Supporting Information may be found in the online version of this article:

**Appendix S1** Peak negative emotions of ANX and CON youth by call number.

**Appendix S2** Interview questions assessing youths' responses to a negative event.

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### Key points

- Theory and research suggests that anxious youth have difficulty regulating emotion. However, little is known about anxious youth's emotional reactivity and emotion regulation in real-world contexts.
- Using a new cell-phone EMA methodology, results suggest that in real-world contexts, anxious youth do not report higher levels of momentary negative emotions but do report heightened negative emotions in response to challenging events.
- Anxious and nonanxious youth also showed no differences in their rates of strategy use; however, acceptance was less effective for down-regulating negative emotion in anxious youth and rumination was particularly counterproductive for down-regulating negative emotion in anxious youth.
- Current findings suggest that the effectiveness of cognitive–behavioral interventions for pediatric anxiety may be enhanced by greater emphasis on coaching anxious youth to use abstract, cognitively based strategies for regulating negative emotion and dampening physiological arousal.

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