

Negative and Positive Emotion Responses to Daily School Problems: Links to Internalizing and Externalizing Symptoms

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Abstract Examining emotion reactivity and recovery following minor problems in daily life can deepen our understanding of how stress affects child mental health. This study assessed children's immediate and delayed emotion responses to daily problems at school, and examined their correlations with psychological symptoms. On 5 consecutive weekdays, 83 fifth graders ($M = 10.91$ years, $SD = 0.53$, 51% female) completed brief diary forms 5 times per day, providing repeated ratings of school problems and emotions. They also completed a one-time questionnaire about symptoms of depression, and parents and teachers rated child internalizing and externalizing problems. Using multilevel modeling techniques, we assessed within-person daily associations between school problems and negative and positive emotion at school and again at bedtime. On days when children experienced more school problems, they reported more negative emotion and less positive emotion at school, and at bedtime. There were reliable individual differences in emotion reactivity and recovery. Individual-level indices of emotion responses derived from multilevel models were correlated with child psychological symptoms. Children who showed more negative emotion reactivity reported more depressive symptoms. Multiple informants described fewer internalizing problems among children who showed better recovery by bedtime, even after controlling for children's average levels of

exposure to school problems. Diary methods can extend our understanding of the links between daily stress, emotions and child mental health. Recovery following stressful events may be an important target of research and intervention for child internalizing problems.

Keywords Emotion reactivity · Emotion recovery · Positive emotion · Internalizing problems · Daily diary · School problems

The adverse effects of psychosocial stress on child mental health are often mediated by difficulties with effectively managing emotions (Crowell et al. 2015; Repetti et al. 2002). School is one source of such stress; negative events such as making a mistake on a test or arguing with a peer are common in the daily lives of school-aged children. If chronic or severe, problems at school can elevate risk for internalizing (i.e., anxiety, depression) and externalizing (i.e., disruptive behaviors, aggression) problems (Reijntjes et al. 2010, 2011). However, the way that children react and cope in the face of daily stressors can mitigate their effects on psychological functioning (Clarke 2006; Sontag et al. 2008). Some children may even demonstrate positive development despite exposure to such adversities (Luthar et al. 2000).

One approach to further understanding the link between exposure to negative events at school and child mental health is to investigate same-day emotion responses to these problems (Repetti et al. 2011). Emotions are defined as affective responses to specific events. They often give rise to behaviors, and can be modulated through the use of various coping strategies (Gross 2015). Using intensive repeated ratings of school problems and emotions from 83 fifth graders, this study assessed children's emotion responses to daily school problems, and examined how

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between-person differences in emotion responses were associated with child psychological symptoms. For most children, fifth grade marks the final year of elementary school, before their transition to middle school. The rigor and demands of school work steadily increase throughout elementary school in preparation for middle school, and the quality of peer relationships during this period can predict physical and mental health in adolescence (Bogart et al. 2014). Assessing risk factors for mental health problems during this period, using measures that minimize recall and response bias, is an important priority.

The current study uses daily repeated measures of school problems and negative and positive emotions to differentiate between *emotion reactivity* and *recovery*. *Emotion reactivity* is operationalized as a significant within-person association between school problems and emotion measured at school. Separate from emotion reactivity is *recovery*, which is represented by a child's within-person association between problems rated at school and emotion rated at bedtime. Complete recovery is marked by the absence of a significant link between problems at school and emotion at bedtime. Daily diary studies have traditionally examined spillover, defined as the short-term process by which stressful experiences in one setting negatively influence experiences in another setting. Accordingly, emotions triggered by negative events at school often influence interactions at home (Bai et al. 2016; Lehman and Repetti 2007). This study focuses on emotion reactivity to and recovery from negative events at school, and examines between-person variability in the daily link between school problems and emotion.

Emotion Reactivity to Daily School Problems

School-age children react to school problems with concurrent elevations in negative emotion (Morrow et al. 2014; Schneiders et al. 2006) and decreases in positive emotion (Flook 2011; Schneiders et al. 2006). For example, in an 8-day diary study, fifth grade children reported more negative emotion on days when they experienced any type of peer victimization (Morrow et al. 2014). Likewise, stressful events were linked to low positive emotion, in an experiential sampling study of young European adolescents (Schneiders et al. 2006). Negative and positive emotion uniquely affect child functioning in both the short- and the long-term. In the short-term, negative emotion may spill over from the school to the home and generate more stressful events (e.g., parent-child conflict) that day (Lehman and Repetti 2007). In contrast, positive emotion promotes action, social connection, motivation and cognitive flexibility – attributes needed for learning, problem solving, and support seeking (Fredrickson 2001). A decrease in positive emotion may lead children to withdraw from possibly helpful social interactions with teachers, parents, and peers.

At the trait level, poor negative and positive emotion regulation is closely linked to child psychopathology (Gilbert 2012; Repetti et al. 2002). In particular, poor regulation of positive emotion has been linked to bipolar disorder and externalizing disorders (Gilbert 2012), whereas low positive emotion uniquely differentiates child depression from other internalizing disorders (Chorpita and Daleiden 2002). Given their unique effects on child psychological functioning and development, negative and positive emotion are important targets of research investigation. The current study attempts to replicate previous findings of negative emotion reactivity and build on the emerging evidence of positive emotion reactivity to school problems, using diary data.

We focus on individual differences in children's negative and positive emotion responses to negative events. Although many studies have used intensive repeated methods to describe within-person associations between school problems and emotion, few have explored individual differences in the strength of that association. Two studies examining how child psychological functioning moderates same-day links between negative events and emotion indicate that emotional reactions to spontaneously occurring negative events vary between individuals (Schneiders et al. 2006; Timmons and Margolin 2015). However, we know of only one diary study that derived individual measures of negative and positive emotion reactivity in children; Robles et al. (2016) obtained individual measures of emotion reactivity to marital conflict and related them to biological markers of aging. Our approach addresses a significant gap in the research literature inasmuch as individual differences in emotion reactivity to everyday stress may represent an important component of child mental health.

Emotion Recovery from Daily School Problems

As with emotion reactivity, negative and positive emotion recovery may vary significantly between individuals and be influenced by gender, age and cognitive functioning. Investigations of emotion recovery based on laboratory analogs of peer rejection often monitor changes in child emotion over several minutes (Adrian et al. 2011). These studies focus on cognitive and behavioral responses that are expected to modulate children's emotion expressions over brief periods of time (e.g., distraction, problem solving). However, the time course of emotion recovery, separate from emotion reactivity, is not well understood.

Diary methods can complement laboratory observational methods by assessing the lingering effects of everyday stress on child emotion over several hours, including the transition from school to home contexts. A lack of recovery would suggest that problems at school negatively affect emotions across contexts, whereas recovery may reflect effective emotion

regulation. The successful modulation of an emotional response to a minor stressor may promote self-efficacy and resilience against the detrimental effects of subsequent stressors (Rutter 2012). Despite their potential unique contribution, diary studies of recovery are rare and limited to the examination of the effects of stressors on next day mood (Chung et al. 2011). Although these studies can control for various day-level covariates, it is not possible to accurately account for all that can happen to influence emotion over 24 h.

Emotion Response to Stress and Child Psychological Symptoms

Emotion reactivity and recovery may be key processes that link school-related stress to child psychological problems (Crowell et al. 2015; Reijntjes et al. 2010, 2011). The association between emotion regulation and internalizing problems has been established through a number of studies (Hastings et al. 2007; McLaughlin et al. 2009). However, analyses of the link between emotion regulation and externalizing problems have not been as consistent (Cooley and Fite 2015; Hastings et al. 2007; Herts et al. 2012). Although most investigations suggest that better emotion regulation is linked to fewer externalizing problems or aggression, Hastings et al. (2007) found that greater positive affect during a socially challenging laboratory task was associated with more externalizing problems.

In addition, while there is abundant research differentiating adaptive coping strategies such as cognitive reappraisal, from maladaptive ones like rumination (Aldao et al. 2010), we know little about how these strategies may help children recover from stressful events throughout the day. Observational methods improve on questionnaires by directly assessing immediate emotional and behavioral responses to specific events (e.g., Morris et al. 2011). Still, few studies of emotion responses to stressful events examine how emotion intensity changes over several hours. Even fewer have assessed the links between problems at school, emotional responses to these events, and child psychological functioning.

Although higher levels of daily stress are typically associated with poorer psychological functioning, mild negative events such as doing poorly on a test or arguing with a friend may also afford children the opportunity to practice coping and promote positive development (Repetti and Robles 2016). An empirical study of recovery may help to differentiate possible gains associated with exposure to mild stress from detrimental effects. Studies using experience sampling method or daily diaries suggest that child emotion reactivity to and recovery from daily stress are concurrently associated with child adjustment (Neumann et al. 2011; Silk et al. 2003). Silk et al. (2003) examined declines in negative emotions over 1 h time periods following negative events during a 1-week long experiential sampling methods study. They found that children who were more likely to react to a negative event

with negative emotion and not recover within an hour had more psychological problems than those who reacted and then recovered. The current study extends past research by using multilevel modeling methods to derive continuous between-person measures of reactivity and recovery. We examine how between-person differences in reactivity and recovery are associated with psychological symptoms, over and above exposure to school problems.

Some evidence points to possible gender differences in the association between emotion regulation and psychological functioning. Individual differences in constructs related to emotion regulation, such as distress tolerance or rumination, may be linked to internalizing problems among girls but not boys (Daughters et al. 2009; Tompkins et al. 2011). Moreover, teachers and clinicians often rate boys as having more externalizing problems than girls (Bruchmüller et al. 2012; Miner and Clarke-Stewart 2008). Our study tests whether the association between emotion reactivity and recovery and psychological problems differ by gender.

Current Study

Children in the current study completed self-reports of school events and emotion, several times per day, for 5 consecutive weekdays. The intensive repeated data were used to derive individual-level estimates of emotion reactivity to school problems and emotion recovery by bedtime. Cross-sectional associations between those emotion response variables and child-reported depression symptoms, and parent- and teacher-reported internalizing and externalizing problems were tested. We hypothesized that higher levels of reactivity and poor emotion recovery would be associated with more psychological symptoms, over and above average levels of problems at school. Child sex differences in those associations were explored.

Methods

Participants

Data were collected as part of a larger 3-year study of stress and family development. Children and parents were recruited through one parochial and two public schools in the greater Los Angeles area. A total of 677 families with fourth-grade children were invited to participate for the larger longitudinal study, and parental consent was obtained from 248 (37%). Of these children, 230 participated the following year, in the fifth grade (McGrath and Repetti 2002). Data for this paper comes from a diary study conducted on a subset of eligible participants in the fifth grade. To be eligible for the diary study, all members of the family (including both parents in two-parent families) had to have participated in the first year of the

longitudinal study, and any parent living with the child had to be employed at least part-time. These criteria were established to address questions about the effects of parents' jobs that are not relevant to this article. Of the 230 fifth grade children in the larger study, 112 were eligible and invited to participate in the diary portion. Of these children, 74% or 83 children (51% girls) chose to participate.

Of the 83 children in the current study, the majority ($n = 71$) of the students completed the diary in Spring of fifth grade; a small minority ($n = 12$) completed it during Fall of sixth grade. Mean child age during the diary phase was 10.91 years ($SD = 0.53$). Of the 83 children, 79% were White, and 21% had at least one parent who was not White. Sixty percent of the families reported annual incomes greater than \$80,000 USD in years 1993 to 1996. Of the 83 children, 65% lived with both parents (mother and father) and 35% lived with one parent. Chi-square tests of independence did not indicate any demographic differences between eligible families that did and did not participate in the daily report study (Lehman and Repetti 2007).

In addition to child participants, 70 mothers, 55 fathers and 73 teachers completed one-time questionnaires about child symptomatology during the diary year. Two sample t-tests with unequal variance did not indicate any differences between children who completed the diaries during the fifth grade and those who completed it during the sixth grade, with respect to aggregate measures of school problems, negative mood and positive mood, and child-, parent- and teacher-ratings of psychological functioning.

Procedures

The 83 children in the current study completed five diaries each day for 5 consecutive weekdays (Mon to Fri) about emotion, school events, and family interactions. For the data described in the article, parent consent and child assent was obtained twice: at the start of the longitudinal study, and again at the start of the diary study (during a home visit). In addition to the diaries, children completed one-time questionnaires in group interview format at school. Group interviews were administered by research assistants. Parents and teachers also completed questionnaires about child psychological symptoms. Paper questionnaires were mailed home to parents and were delivered to teachers at school. Parents and teachers were provided with postage-paid envelopes to mail completed forms back to the researchers. All questionnaires were completed within the same school year as the diaries. On average, they were completed within the same month of the diaries (SD ranged from 1.45–1.98 months). At most, they were completed 6 months prior to or 7 months after the diaries. Children received \$20 for their participation in the diary study. In each year of the larger longitudinal study, children received \$5–10 and parents received \$10–20, with the amount increasing over

the 3 years. Teachers received \$5 for each questionnaire they completed. The university's institutional review board approved all study procedures.

Diary Procedures Research staff provided instructions to children about diary procedures during home visits. On each of the 5 weekdays, children completed brief paper-and-pencil diary forms 5 times per day: morning, just before lunch, end of the school day, early evening and bedtime. Lunch and end-of-school-day diaries were completed at school, while all others were completed at home. Several steps were taken to increase compliance. Children received beeper watches that reminded them to complete the two forms at school and parents, who were also completing diaries during the same period, provided reminders in the mornings and evenings at home. In addition, families received evening telephone calls, which acted as daily reminders and opportunities to address any questions or difficulties that may have arisen. Children were reminded to leave blank any forms that had not been completed on time that day. Each participant received preaddressed and stamped envelopes to return reports at the end of each day. Most opted to store their completed diaries in a personal carrying case equipped with sections for each day's reports; the cases were picked up at the end of the week. Compliance was high, with the average child completing 24.50 ($SD = 1.93$), out of the 25 expected diaries.

Measures

Child Diary

Children completed the Youth Everyday Social Interaction and Mood measure (YES-I-AM; Repetti 1996), several times a day each day. The YES-I-AM measure contains subscales that assess peer problems, academic problems, positive emotion and negative emotion at several points in the day.

School Problems Children completed ten questions about problems at school twice each day: just before lunch and at the end of the school day. The lunch time diary asked children to describe the morning at school, and the end of the school day diary asked children to describe the afternoon at school. On each survey, children responded to five items that assessed academic problems (e.g., "I made a mistake in class", "I had trouble finishing my schoolwork") and five that assessed peer problems (e.g., "Another kid teased me", "I felt that my friends didn't want to be around me"; Lehman and Repetti 2007; Repetti 1996). The response options for the 10-item school problems scale ranged from 1 (*definitely false*) to 4 (*definitely true*). Responses were averaged across 10 items at each assessment, then again across the two assessments each day to create a daily school problems score. Between-person reliability, defined as the ability to reliably detect differences

between individuals ($R_{KF} = 0.95$) and within-person reliability defined as the ability to reliably detect changes within individuals ($R_C = 0.62$) were adequate for the total school problems scale; Cronbach’s alphas across the 5 days ranged from 0.75 to 0.87. The intraclass correlation coefficient (*ICC*), an index of the proportion of the variance attributable to between-individual differences as opposed to within-person differences was 0.65. Descriptive statistics are shown in Table 1. School problems were grand mean centered in all within-subject analyses.

Negative and Positive Emotion Separate from questions about problems at school, children rated 10 items assessing negative emotion (e.g., “I was tense,” “I was confused,” “I felt scared,” “I felt sad”) and 7 items related to positive emotion (e.g., “I was proud,” “I felt happy,” “I felt excited,” “I was confident”) as part of the YES-I-AM scales (Lehman and Repetti 2007; Repetti 1996). Items were rated 4 times each day - morning, just before lunch, end of school day, and bedtime – on a 4-point scale, with options ranging from 1 (*definitely false*) to 4 (*definitely true*). Item scores were averaged to create negative emotion and positive emotion scale scores at each assessment. Between- and within-person reliability estimates for negative emotion were adequate ($R_{KF} = 0.96$, $R_C = 0.67$); Cronbach’s alpha ranged from 0.75 to 0.91 across assessments. Between- and within-person reliability estimates

for positive emotion were adequate as well ($R_{KF} = 0.97$, $R_C = 0.52$); Cronbach’s alpha ranged from 0.81 to 0.92.

The current study uses negative emotion and positive emotion scale scores from the just before lunch, end-of-school-day and bedtime assessments. Emotion scores from the lunch and end-of-school-day assessments were averaged each day to create daily measures of school negative emotion and school positive emotion, and used to assess emotion reactivity. Bedtime negative emotion and positive emotion scale scores were used to assess emotion recovery. *ICC* estimates for negative emotion at school and at bedtime were 0.55 and 0.53, respectively. For positive emotion, the *ICCs* were 0.71 at school and 0.64 at bedtime. Three children with consistently outlying positive emotion scores (more than $2.5 \times SD$ below the mean) were excluded from all analyses involving positive emotion.

Questionnaire Measures

Depressive Symptoms *Children’s Depression Inventory* (CDI; Kovacs 1985) is a 27-item questionnaire that assesses children’s self-reports of affective, behavioral, somatic and cognitive symptoms of depression. Children responded to each item by indicating which of three sentences best describe how they have felt during the last 2 weeks (e.g., “I am sad once in a while, I am sad many times, I am sad all the time”). Each statement was linked to a score (0, 1 or 2) and scores from 27 questions were averaged. Higher average scores indicated more symptoms of depression. The CDI shows strong psychometric properties, including high test-retest reliability, concurrent validity and predictive validity for depression (Carey et al. 1987). Cronbach’s alpha was 0.78 in this study.

Table 1 Descriptive statistics for reactivity, recovery and child psychological symptoms

	N	Mean	SD	Min	Max
Aggregated daily variables					
Average school problems	83	1.50	0.44	1.00	3.23
Negative school emotion	83	1.37	0.43	1.00	2.87
Positive school emotion	80	3.30	0.53	2.04	4.00
Negative bedtime emotion	83	1.38	0.45	1.00	3.10
Positive bedtime emotion	80	3.24	0.58	1.82	4.00
Emotion response to problems					
Negative emotion reactivity	83	0.46	0.18	0.21	1.04
Negative emotion recovery ^{a, b}	83	-0.39	0.28	-1.63	-0.06
Positive emotion recovery ^a	80	-0.32	0.20	-0.99	0.11
Child psychological symptoms					
Child – CDI	82	0.16	0.16	0	0.70
Parent – Internalizing	76	0.20	0.18	0	0.94
Parent – Externalizing	76	0.22	0.19	0	0.94
Teacher – Internalizing	73	0.08	0.11	0	0.44
Teacher – Externalizing	73	0.09	0.15	0	0.82

CDI Children’s Depression Inventory

^a Higher scores indicate higher levels of recovery;

^b Values were reverse coded (multiplied by -1) for ease of interpretation

Parent Report of Child Internalizing and Externalizing Problems The *Child Behavior Checklist* is a widely used 113-item parent measure of child emotional and behavioral functioning (CBCL; Achenbach 2009). It shows good psychometric properties, including high test-retest reliability and high external validity (Achenbach 2009). The current study uses the internalizing problems (31 items; withdrawn, somatic complaints and anxious/depressed subscales) and externalizing problems (33 items; aggressive and delinquent behaviors subscales) broad-band scales. Mothers and fathers independently rated items on a 0 (*not true*) to 2 (*very true or often true*) scale. Items were averaged for each rater, with higher scores indicating more problems. In the current study, the internal consistency of the broad-band scales ranged from 0.89 to 0.91. Mother and father scores were highly correlated, $r(40) = 0.53$ and 0.60 for internalizing problems and externalizing problems, respectively. In order to limit the number of tests and because of the high correlation between mother and father CBCL scores, mother and father scores were averaged

whenever both scores were available. Descriptive statistics for combined parent scores are shown in Table 1.

Teacher Report of Child Internalizing and Externalizing Problems *Teacher Report Form* (TRF; Achenbach 2009) is a widely used 113-item teacher questionnaire that parallels the CBCL. It has been shown to be a reliable, stable, and valid measure of child psychological adjustment (Achenbach 2009; Edelbrock and Achenbach 1984). As described above, the current study uses the internalizing problems (36 items) and externalizing problems (34 items) broad-band scales. All items are rated on a 0 (*not true*) to 2 (*mostly true*) scale, and averaged, with higher scores indicating higher levels of symptoms. Internal consistency for internalizing problems and externalizing problems were high, $\alpha = 0.81$ and 0.92 , respectively.

Data Analysis

The data were analyzed in three stages. First, multilevel linear regression analyses (PROC MIXED in SAS) evaluated emotion reactivity to and recovery from daily school problems. In each of the four separate analyses, the predictor variable was daily school problems; the outcome variables were negative and positive emotion at school (to assess reactivity) and bedtime negative and positive emotion (to assess recovery). The multilevel models (MLMs), with days (Level 1) nested in children (Level 2), tested the within-person effect of school problems on emotion while allowing the intercept and slope to randomly vary between individuals (Raudenbush and Bryk 2002). This approach excluded observations with missing data using listwise deletion. A first order autoregressive structure was specified for residuals to correct for time dependencies across days, and the school problems variable was grand mean centered. Eqs. (1), (2) and (3) further describe this two-level approach:

$$\text{Level 1 : } Emotion_{ij} = \beta_{0j} + \beta_{1j} Problems_{ij} + e_{ij} \quad (1)$$

$$\text{Level 2 : } \beta_{0j} = \gamma_{00} + u_{0j} \quad (2)$$

$$\beta_{1j} = \gamma_{10} + u_{1j} \quad (3)$$

As described in Eq. (1), emotion for child j on day i ($Emotion_{ij}$) is a linear function of school problems for child j on day i ($Problems_{ij}$). Child j 's intercept, β_{0j} , is the sum of γ_{00} , the average level of emotion across all days and all children, and u_{0j} , child j 's deviation from this average (see Eq. 2). As shown in Eq. (3), β_{1j} , is the sum of γ_{10} , the average linear effect of school problem ($Problems_{ij}$) on emotion ($Emotion_{ij}$), and u_{1j} , child j 's deviation from this average slope, over and above the child's average level of emotion across all diary days (β_{0j}), and correcting for time dependencies of errors across days.

The second stage of analysis depended on the random slope effects from the MLMs, which represent the between-person variance in slopes (u_{1j}). In each of the four MLMs, we examined this variance estimate as an indicator of the extent to which the within-person association between school problems and emotion varied between children. We conducted likelihood ratio tests of the variance component for school problems to determine whether the slope estimate significantly varied between individuals. When there was significant between-person variance in slope, we derived empirical Bayes (EB) estimates of that slope for each child (centered to the average slope, γ_{10}) to use as predictors (see Mohr et al. 2013 as an example). The estimation accounts for fixed effects at Level 1 (i.e., intercept) and the size of each child's sample, by "borrowing" strength from children with more data points (Raudenbush and Bryk 2002). The EB estimates of the individual slopes of the association between school problems and emotion at school was used as a between-persons measure of emotion reactivity (Robles et al. 2016). Likewise, the individual EB estimates of the association between school problems and emotion at bedtime was used as a between-persons measure of recovery.

Associations between the individual-level measures of reactivity, recovery and child symptoms were tested in the third stage of the analysis. Child sex differences were assessed in multiple linear regression analyses, through interactions between child sex and the reactivity/recovery variable. We further tested the incremental validity of reactivity and recovery by examining their links to child symptoms while controlling for average levels of school problems (daily ratings averaged across the 5 days), in multiple linear regression analyses. All outliers at the individual level of analysis ($2.5 \times SD$ above or below the mean) were winsorized. Data analyses were conducted on SAS 9.4 software or Stata 13.1 software.

Results

Emotion Reactivity and Recovery

Reactivity Negative emotion and positive emotion at school were separately examined as the dependent variable in two MLMs; school problems were the predictor in both models.

For the average child, more school problems were associated with higher levels of negative emotion at school that day, $\gamma_{10} = 0.46$, $SE = 0.06$, $t = 7.46$, $p < 0.001$. There was individual variability in negative emotion reactivity, as indicated by a significant likelihood ratio test of the variance component for school problems, $X^2(2) = 21.70$, $p < 0.001$. Figure 1 depicts the individual slopes using raw day-level scores for school problems and emotion. As shown in Table 1, the EB estimates of negative emotion reactivity ranged from 0.21 to 1.04, with higher values representing stronger reactivity.

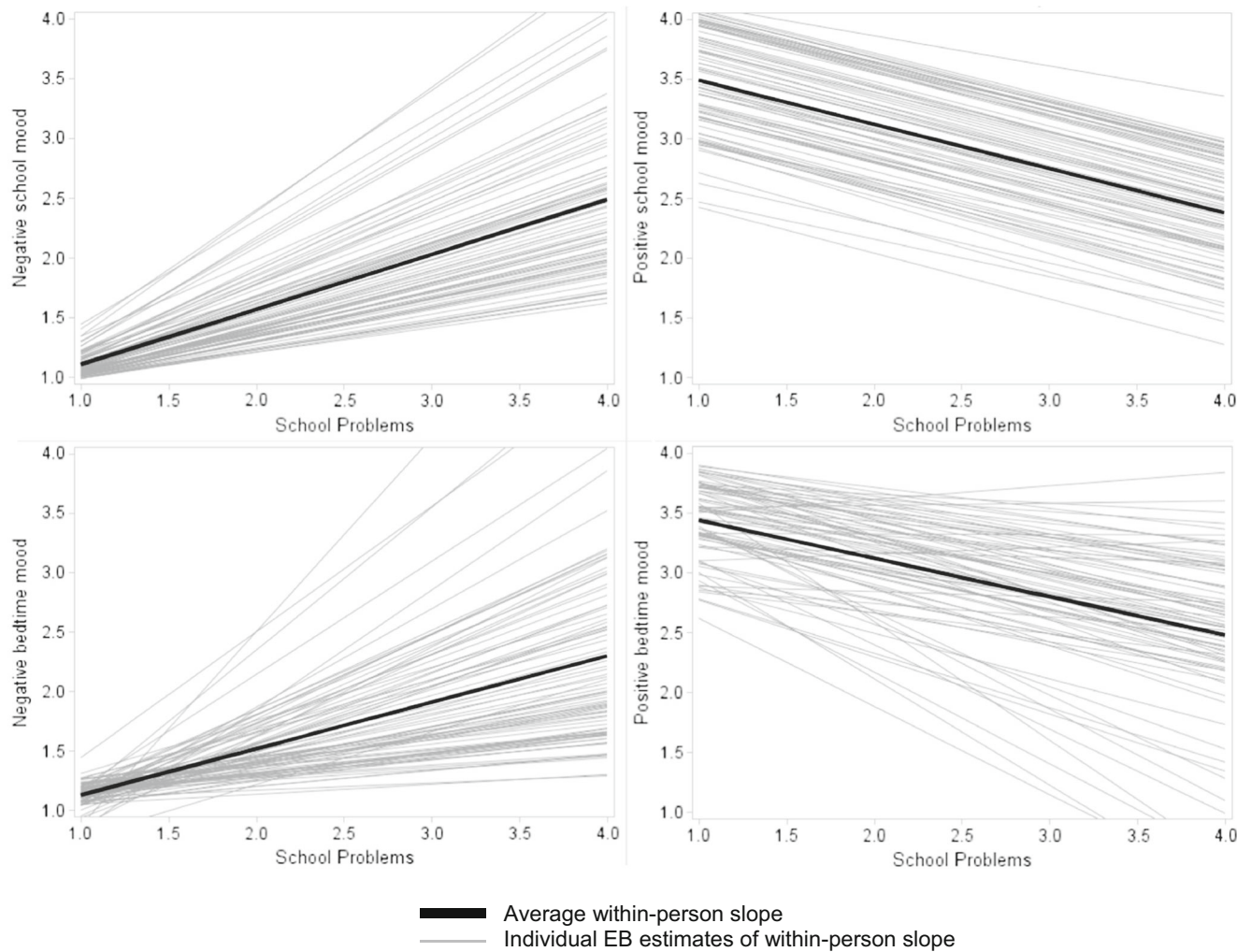


Fig. 1 Within-person associations between school problems and negative and positive emotion at school and at bedtime

Likewise, the average child reported lower levels of positive emotion at school on days with school problems, $\gamma_{10} = -0.27, SE = 0.07, t = -3.91, p < 0.001$. The random effect on this slope was not significant according to the likelihood ratio test of the variance component for school problems, $X^2(2) = 0.30, p = 0.861$, suggesting that individuals did not vary in the intensity of their positive emotion responses to school problems (see Fig. 1). Thus, we did not derive individual-level estimates of positive emotion reactivity.

Recovery Next, we examined whether daily school problems predicted same-day emotion at bedtime, with negative and positive emotion tested in separate MLMs. All other model specifications were consistent with the reactivity models.

For the average child, more problems at school were associated with higher levels of negative emotion at

bedtime that night, $\gamma_{10} = 0.39, SE = 0.07, t = 5.57, p < 0.001$, which is consistent with negative emotion spillover rather than recovery. The strength of this association varied quite a bit across individuals (see Fig. 1), as indicated by a significant likelihood ratio test of the variance component for school problems, $X^2(2) = 38.20, p < 0.001$. When deriving individual-level estimates of negative emotion recovery, EB estimates were reverse coded (multiplied by -1) for ease of interpretation: higher values represented greater recovery (i.e., a weaker association between school problems and bedtime negative emotion). As shown in Table 1, the mean negative emotion recovery score was equal to the unstandardized coefficient (γ_{10}) in magnitude but in the opposite direction.

As with negative emotion recovery patterns, more school problems also predicted a decline in positive emotion that night for the average child, $\gamma_{10} = -0.32, SE = 0.11, t = -3.02, p = 0.003$. The likelihood ratio

test of the variance component for school problems was significant, $\chi^2(2) = 7.20, p = 0.027$, suggesting that the strength of the association between school problems and bedtime positive emotion differed between children (see Fig. 1). The mean positive emotion recovery score was consistent with the unstandardized coefficient in the MLM (γ_{10}) and ranged from -0.99 to 0.11 across individuals. Higher values indicated better recovery, defined as a weaker association between school problems and that night's positive emotion.

Associations Between Reactivity, Recovery, and Child Symptoms

The individual-level estimates of negative emotion reactivity and negative and positive emotion recovery, which assess daily emotion responses to school problems, were linked to five measures of mental health. We begin by first describing the correlations between individual-level measures of reactivity and recovery, and among the measures of psychological symptoms. As shown in Table 2, three correlations tested the associations between one measure of reactivity and two measures of recovery. Negative emotion recovery and positive emotion recovery were positively correlated. In addition, higher values for negative emotion reactivity were correlated with lower values for both negative emotion recovery and positive emotion recovery. The correlations among the five mental health measures showed that child ratings of depression symptoms were correlated with both parent- and teacher-ratings of internalizing problems. Parents and teachers' reports of internalizing problems were not correlated,

although they agreed on ratings of child externalizing problems. Within each reporter, internalizing problems were positively correlated with externalizing problems.

Negative Emotion Reactivity and Child Symptoms Out of the five cross-sectional correlations between negative emotion reactivity and five measures of child symptoms, only one was statistically significant (Table 2). More negative emotion reactivity was associated with more child-reported symptoms of depression. Only one of the five interaction terms testing child sex differences was statistically significant: the association between negative emotion reactivity and teacher-rated externalizing problems differed for boys and girls, $b = -0.50, SE = 0.17, t = -2.89, p = 0.005$. Negative emotion reactivity was correlated with more teacher-rated externalizing problems among boys, $r(33) = 0.45, p = 0.007$, but not among girls, $r(36) = -0.10, p = 0.556$.

Next, five linear regression models tested associations between negative emotion reactivity and child symptoms, controlling for average levels of school problems. As shown in Table 3, the association between negative emotion reactivity and child-reported symptoms of depression held, even when controlling for average school problems. Consistent with the correlations, negative emotion reactivity was not associated with parent- or teacher-reports of internalizing problems (see Table 3), nor was it linked with parent-ratings of externalizing problems, $b = 0.06, SE = 0.12, t = 0.50, p = 0.616$. For teacher-ratings of externalizing problems, the interaction between negative emotion reactivity and child sex was significant, $b = -0.47, SE = 0.18, t = -2.72, p = 0.008$, controlling for average school problems. More negative emotion reactivity was associated with more externalizing problems in boys,

Table 2 Correlation matrix of bivariate associations between school problem reactivity, recovery, and child psychological symptoms

	1	2	3	4	5	6	7	8	9	10	11	12
Aggregate daily variables												
1 Average school problems												
2 Negative school emotion	0.77***											
3 Positive school emotion	-0.47***	-0.48										
4 Negative bedtime emotion	0.77***	0.90***	-0.43***									
5 Positive bedtime emotion	-0.36	-0.35***	0.81***	-0.38***								
Emotion response to problems												
6 Negative emotion reactivity	0.38***	0.84***	-0.33**	0.72***	-0.24*							
7 Negative emotion recovery	-0.40***	-0.74***	0.34**	-0.85***	0.37***	-0.78***						
8 Positive emotion recovery	-0.13	-0.28*	0.38***	-0.27*	0.45***	-0.22*	0.37***					
Child psychological symptoms												
9 Child - CDI	0.48***	0.50***	-0.50***	0.46***	-0.49***	0.36***	-0.37***	-0.31**				
10 Parent - Internalizing	0.15	0.18	-0.27*	0.17	-0.31**	0.14	-0.24*	-0.13	0.032**			
11 Parent - Externalizing	0.13	0.10	-0.20	0.04	-0.18	0.10	-0.02	-0.03	0.16	0.69***		
12 Teacher - Internalizing	0.21	0.28*	-0.31**	0.30*	-0.32**	0.22	-0.29*	-0.28*	0.37**	0.22	0.04	
13 Teacher - Externalizing	0.11	0.06	-0.15	0.02	-0.01	0.10	0.02	0.13	-0.05	0.04	0.35**	0.29*

All variables winsorized to 2.5xSD above or below the mean

CDI Children's Depression Inventory

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 Multiple regression analyses testing associations between emotion responses to stress and child-, parent-, teacher-report of child internalizing symptoms, over and above average levels of school problems

Predictors	Outcomes											
	Child self-reported depression scores				Parent ratings				Teacher ratings			
	b (SE)	t	p	[95% CI]	b (SE)	t	p	[95% CI]	b (SE)	t	p	[95% CI]
Negative emotion reactivity models												
Reactivity	0.18 (0.09)	2.11	0.038	[0.01, 0.35]	0.09 (0.11)	0.79	0.430	[-0.13, 0.31]	0.10 (0.07)	1.42	0.161	[-0.04, 0.25]
School problems	0.16 (0.04)	4.29	<0.001	[0.08, 0.23]	0.04 (0.05)	0.91	0.365	[-0.05, 0.14]	0.03 (0.03)	1.09	0.279	[-0.03, 0.09]
	$R^2 = 0.30$; $F(2,79) = 16.64$, $p < 0.001$				$R^2 = 0.03$; $F(2,73) = 1.13$, $p = 0.329$				$R^2 = 0.07$; $F(2,70) = 2.46$, $p = 0.093$			
Negative emotion recovery models												
Recovery	-0.12 (0.06)	-2.01	0.048	[-0.24, 0]	-0.14 (0.08)	-1.77	0.081	[-0.29, 0.02]	-0.10 (0.05)	-1.98	0.052	[-0.20, 0]
School problems	0.15 (0.04)	4.17	<0.001	[0.08, 0.23]	0.03 (0.05)	0.54	0.592	[-0.07, 0.12]	0.02 (0.03)	0.75	0.456	[-0.04, 0.09]
	$R^2 = 0.29$; $F(2,79) = 16.35$, $p < 0.001$				$R^2 = 0.06$; $F(2,73) = 2.41$, $p = 0.097$				$R^2 = 0.09$; $F(2,70) = 3.46$, $p = 0.037$			
Positive emotion recovery models												
Recovery	-0.18 (0.08)	-2.38	0.020	[-0.34, -0.03]	-0.09 (0.10)	-0.89	0.374	[-0.29, 0.11]	-0.13 (0.06)	-2.19	0.032	[-0.25, -0.01]
School problems	0.17 (0.03)	5.05	<0.001	[0.11, 0.24]	0.06 (0.04)	1.34	0.184	[-0.03, 0.14]	0.05 (0.03)	1.78	0.079	[-0.01, 0.10]
	$R^2 = 0.32$; $F(2,76) = 18.15$, $p < 0.001$				$R^2 = 0.04$; $F(2,71) = 1.54$, $p = 0.221$				$R^2 = 0.12$; $F(2,67) = 4.49$, $p = 0.015$			

All variables winsorized to 2.5xSD above or below the mean; N ranged from 70 to 82

b unstandardized coefficient, SE standard error; CI confidence interval

$b = 0.42$, $SE = 0.15$, 95% CI [0.11, 0.72], but not for girls, $b = -0.06$, $SE = 0.10$, 95% CI [-0.25, 0.13].

Negative Emotion Recovery and Child Symptoms As shown in Table 2, three out of five correlations between negative emotion recovery and child psychological problems were statistically significant. Children who showed stronger negative emotion recovery were described by both their parents and their teachers as having fewer internalizing problems, and they also self-reported fewer symptoms of depression. There were no child sex differences in any of the associations between emotion recovery scores and child symptoms.

Five multiple linear regressions tested the association between negative emotion recovery and child symptoms, over and above average levels of problems at school. As shown in Table 3, negative emotion recovery was associated with parent- and teacher-report of child internalizing problems, $p < 0.10$, and with child self-reported depression symptoms, $p < 0.05$, controlling for average school problems. Consistent with the correlations in Table 2, negative emotion recovery was not associated with parent-ratings, $b = 0.02$, $SE = 0.08$, $t = 0.23$, $p = 0.821$, or teacher-ratings, $b = 0.04$, $SE = 0.06$, $t = 0.64$, $p = 0.523$, of child externalizing problems.

Positive Emotion Recovery and Child Symptoms For positive emotion recovery, two out of five correlations were significant (see Table 2). Better positive emotion recovery following difficult days at school was associated with fewer child-reported depression symptoms and fewer teacher-reported internalizing problems. The correlations

for boys and girls did not differ. Follow-up multiple regression analyses indicated that the two significant associations held even when controlling for average school problems. As with negative emotion recovery, there was no link with parent reports, $b < 0.01$, $SE = 0.11$, $t = -0.01$, $p = 0.996$, or teacher reports, $b = 0.09$, $SE = 0.07$, $t = 1.25$, $p = 0.217$, of externalizing problems.

Discussion

A unique diary approach investigated how individual differences in children’s emotional responses to daily school problems were linked to psychological symptoms. On days when the average child reported more school problems, he or she endorsed more negative and less positive emotion at school, and more negative and less positive emotion at bedtime. We found between-person differences in negative emotion reactivity, negative emotion recovery, and positive emotion recovery. Individual-level measures of all three daily emotion response variables were associated with self-reported depression, even after controlling for average levels of problems at school. In addition, children who showed more negative and positive emotion recovery by bedtime were described by their teachers as having fewer internalizing problems.

Emotion Responses to Daily Stressors

The current study took advantage of intensive repeated ratings of child emotion to examine how problems at school affected

emotional states throughout the day. Consistent with past diary studies, we found that children reacted to minor academic and social problems with more negative emotion and less positive emotion at school (Morrow et al. 2014; Schneiders et al. 2006). Problems at school also affected emotion at bedtime. As previously reported (Lehman and Repetti 2007), children endorsed more negative emotion and less positive emotion at bedtime on more stressful school days.

Underlying many laboratory studies of emotion responses to stress is the assumption that recovery occurs over minutes (e.g., Morris et al. 2011). However, our measure of recovery assessed the extent to which emotion at home later at night continued to be correlated with earlier events at school. Our data indicate that many children experience more negative emotion and less positive emotion for hours following a stressful event. Rather than recovering, spillover from school to home appears to be the norm in the daily lives of fifth graders.

Models of the same-day links between experiences at school and experiences at home propose that negative events at school trigger a cascade of emotional and behavioral reactions in the child, which may generate more stress in the home. For example, children report more negative emotions and perceive more conflict and less warmth with parents at home, following difficult days at school (Chung et al. 2011; Lehman and Repetti 2007; Timmons and Margolin 2015). Children may also withdraw from family members, especially when experiencing less positive emotion (Ramsey and Gentzler 2015). Strained family interactions may in part maintain low positive emotion and high negative emotion, and thus, signs of poor recovery at bedtime.

Although the average child showed more negative emotion and less positive emotion at school and at bedtime on more stressful school days, there was significant variability between individuals. Children differed in the extent to which they reacted to school problems with negative emotion at school and with both negative and positive emotion at bedtime. Positive emotion reactivity did not vary significantly between individuals. In fact, positive emotion at school appeared to be more trait-dependent rather than state-dependent, and thus less amenable to an analysis of within-subjects variance.

Emotion Reactivity, Recovery and Child Symptoms

Using intensive repeated ratings of negative and positive emotion obtained several times a day for 5 consecutive days, we derived three individual-level indices of emotion responses to mild stressors: negative emotion reactivity, negative emotion recovery and positive emotion recovery. Consistent with past research on the link between emotion dysregulation and child internalizing problems, we found that negative emotion reactivity to school problems was correlated with more symptoms of depression (Crowell et al. 2015; Repetti et al. 2002). Only

one child sex difference emerged: more negative emotion reactivity was correlated with more teacher-rated externalizing problems for boys but not girls. Our data suggest that boys who experience high levels of negative emotion reactivity may be more likely to act out compared to emotionally reactive girls. This difference could contribute to the higher prevalence of externalizing problems, such as impulsivity and aggressive behaviors, among boys in school settings (Silver et al. 2005). Boys may also be perceived by teachers as having more externalizing problems (Bruchmüller et al. 2012; Miner and Clarke-Stewart 2008), perhaps due to rating bias.

We assessed recovery and reactivity separately, to test whether the two aspects of stress response are differentially associated with child symptoms. As expected, indices of recovery were also correlated with child psychological symptoms. Better negative emotion recovery by bedtime was associated with fewer child-reported depression symptoms; it was also associated with fewer teacher-reported and parent-reported internalizing problems at trend level. Likewise, better positive emotion recovery was correlated with fewer child-reports of depression symptoms and teacher-rated internalizing problems. Although recovery is considered to be an important component of emotion regulation (Eisenberg and Spinrad 2004), it is rarely assessed in research. Questionnaire measures more often assess emotional reactivity and the use of adaptive and maladaptive coping strategies (e.g., Shields and Cicchetti 1997). Observational studies directly assess child emotions and behaviors in response to stress; however, they focus on overt signs of recovery in the short-term, usually over minutes. Diary studies have shown that even minor stressful events continue to affect emotion and behaviors in the hours to days that follow (Chung et al. 2011). By using diary measures to examine emotion reactivity and recovery, our findings begin to address gaps in research on emotion dysregulation and its links to child mental health.

Naturalistic Assessment of Emotion Responses to Stress

The current study integrates research on daily stress reactivity with research on temperamental correlates of child mental health. Although these literatures are complementary, they are rarely considered together. Diary studies have documented children's daily responses to mild stressors, but the implications of individual differences in those emotion responses for mental health have remained largely unexplored. At the same time, studies of emotion reactivity and child mental health have prioritized the use of standardized questionnaires and laboratory tasks over naturalistic methods with the potential to enhance the external validity of study findings. A few studies have begun to combine these approaches (Schneiders et al. 2006; Timmons and Margolin 2015). Consistent with the results presented here, Schneiders et al. (2006) reported that children with more internalizing and externalizing problems

showed greater decrease in positive emotion and increase in depressed emotion when they experienced a negative family or school related event. Our findings extend our understanding of how short-term emotion responses to minor daily events relate to child psychological functioning. For instance, our data suggest that emotion recovery and average levels of exposure to minor problems at school are inversely linked children's depressive symptoms. Although greater exposure to school problems may be associated with depression, recovery from daily stressors was an indicator of mental health. As argued elsewhere, by providing opportunities for recovery, normative exposure to stress in children's daily lives may contribute to the development of emotion regulation and psychological well being (Repetti and Robles 2016).

Clinical Implications

Assessment tools used in diary studies reduce response and recall biases, and may be adapted to facilitate the daily monitoring of youth experiences in the context of clinical interventions. Monitoring thoughts, mood and behaviors in between intervention sessions using tools such as thought records and mood diaries is an important component of several evidence-based treatments. In interventions, self- and parental-monitoring may increase children's awareness of the links between thoughts, feelings and behaviors (Kauer et al. 2012), as well as improve communication between parents, youths and clinicians. Notably, a study examining change in children's responses to repeated diary questions found that child reports of conflict or warmth with parents did not change with time across 56 consecutive days of diary completion (Reynolds et al. 2016). In healthy children, the act of monitoring alone may not shift perceptions of positive or negative experiences. Nonetheless, monitoring using daily reports may help track children's mood response to real-life events, assess generalizability of intervention effects during the course of treatment, and tailor interventions to the unique needs of each individual.

Results of current study also highlight the importance of addressing the course of emotion recovery throughout the day. Current cognitive-behavioral strategies for youths often target emotion reactivity in the short-term through the use of helpful coping strategies. This study found that children continue to experience more negative mood or less positive mood throughout the day, even with a change in the environment (e.g., school to home). Results suggest that the promotion of emotion recovery during the hours that follow a negative event, in addition to emotion reactivity, may be an important target of clinical research and practice. Seeking support from family members and using cognitive strategies to address ruminative thought patterns may crucially improve children's recovery from stressful events. These components can be fortified in existing interventions, and daily monitoring of

emotional responses to minor events can highlight opportunities to promote recovery in the context of everyday life.

Limitations and Future Directions

Several limitations must be considered when interpreting our findings. First, the sample size and limited age range constrained our statistical power to test the effects of moderators, such as child age, cumulative stress, and family characteristics. Future research with larger and more heterogeneous samples should explore how individual differences in levels of early stress exposure moderate same-day emotion responses to daily negative events. Second, school problems were relatively rare in this sample. Longer diary duration would increase daily variability in both academic and peer problems and more reliably assess child emotion responses to different types of problems. Nonetheless, multiple ratings of emotion within each day across a relatively brief diary period allowed us to assess both reactivity and recovery processes within the same day. Third, given our use of child reports of problems at school, it was not possible to separate cognitive appraisals from the stressful events. Future diary studies could include independent ratings of events or supplement surveys with video observations to investigate the role that appraisals play in emotional reactivity and recovery. Fourth, we cannot evaluate the extent to which the cross-sectional associations reported here represent an effect that emotion reactivity and recovery have on psychological symptoms, versus daily emotion responses as symptoms of child internalizing problems. Although the findings based on parent and teacher reports were not subject to shared method variance, only prospective longitudinal data can test the predictive validity of these measures of emotional reactivity and recovery.

Despite these limitations, the current study represents an important step in applying intensive repeated methodology to assess individual differences in emotion responses to stress. We found that negative emotion reactivity to school problems is correlated with more symptoms of depression. In contrast, children who showed better negative and positive emotion recovery by bedtime displayed fewer depression symptoms. Emotion recovery in the hours that follow minor stressful events may be a logical target of clinical interventions for childhood depression and anxiety.

Compliance with Ethical Standards

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Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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