Published in final edited form as:

J Dev Behav Pediatr. 2009 August ; 30(4): 279. doi:10.1097/DBP.0b013e3181b0ffe4.

Sex differences in the relationship between maternal negative life events and children's laboratory pain responsivity

Subhadra Evans¹, Jennie C.I. Tsao¹, Qian Lu¹, Su C. Kim¹, Norman Turk¹, Cynthia D. Myers^{*}, and Lonnie K. Zeltzer¹

¹ Pediatric Pain Program, Department of Pediatrics, David Geffen School of Medicine at UCLA

Abstract

Objective—Prior research has demonstrated links between psychosocial factors, including negative life events (NLE) and pain in children. The present study examined sex differences in the relationship between mother-reported NLE, child NLE, mother somatization and children's laboratory pain responses for heat, cold and pressure pain tasks. We predicted that maternal NLE would be moderately associated with girls' pain responses, but would not be associated with boys' pain responses.

Method—Participants were 176 non-clinical children (89 boys) aged 8–18 years (mean = 12.2, SD = 2.7) and their mothers. Mothers and children completed questionnaires assessing their perceptions of NLE experienced in the previous 12 months.

Results—Contrary to predictions, maternal NLE were related to pain responses in both boys and girls, although in opposite directions. Thus, increased maternal stress was associated with increased pain responses in girls but with *decreased* pain responses in boys. In addition, the impact of maternal NLE was only apparent for heat and pain tasks, indicating differential effects for various types of pain.

Conclusion—The current findings underscore the importance of family variables in understanding sex differences in children's pain. Future research is needed to examine the mechanisms within the parent-child relationship that contribute to sex-differentiated pain outcomes, particularly under conditions of exacerbated parental stress.

Keywords

negative life events; children's laboratory pain; sex differences

Introduction

Recent epidemiological work indicates that pain is a common experience among children and adolescents^{1, 2}. Current models conceptualize pain as a complex, multidimensional construct, incorporating biological, psychological and social aspects³. Within the biopsychosocial model of pain, factors such as increased stress burden resulting from the experience of negative life events (NLE) are viewed as potential influences on the experience of pain. In accord, prior research has found relationships between children's own life stress and negative health outcomes^{4–7}. Walker and Greene⁸ reported that increased NLE in children with recurrent

Contact for correspondence: Subhadra Evans, PhD, Pediatric Pain Program, Department of Pediatrics, David Geffen School of Medicine at UCLA, 10940 Wilshire Blvd., Suite 810, Los Angeles, California 90024. Telephone: 310-794-2936, FAX: 310-794-2954, suevans@mednet.ucla.edu.

^{*}Deceased

abdominal pain (RAP) were associated with maintenance of pain, anxiety and somatization symptoms. In addition to children's own experiences, the family system is an important context within which stressful NLE experienced by other family members may have an indirect impact on children's symptoms through transmission of stress^{9, 10}.

Reports of NLE have long been considered a proxy variable for stress^{11, 12}. Significant positive associations between family stress, as measured by life events, and an array of childhood illnesses and chronic pain states have been reported^{7, 9, 13}. It is likely that increased family stress, by taxing the individual's capacity for readjustment, impacts psychological and physical functioning⁹. In one longitudinal study, Walker and colleagues¹⁴ reported significant associations between maternal report of NLE experienced by any family member and somatic complaints in children with chronic abdominal pain. They found that in families reporting higher levels of negative family life events, boys whose mothers endorsed high levels of somatic symptoms reported increased levels of somatic symptoms at 1-year follow-up relative to girls. Chambers and colleagues¹⁵ found that in a non-clinical sample, mother's behavior during a laboratory pain task influenced daughters' but not sons' pain intensity during a subsequent pain trial. We also found that among girls, parent fears of anxiety symptoms (i.e., anxiety sensitivity) were significantly associated with child laboratory pain intensity via its contribution to child anxiety sensitivity but no such links were evident in boys¹⁶. Taken together, these findings suggest that maternal states are important for children's acute and chronic pain behavior. Furthermore, maternal behavior in response to stressors may have a greater impact on healthy girls' pain experience compared to boys but the opposite pattern may hold in clinical pain populations. We discuss some of the potential mechanisms behind such sex differences in the discussion. As yet, no studies have tested the impact of family stressors, including maternal NLE, on healthy children's acute pain.

While previous studies examining life events and children's chronic pain have focused on the *number* of NLE in relation to children's symptoms¹⁴, one potentially important factor that may also influence children's pain outcomes is subjective appraisal of the impact of life events. Summing life events is a common method for determining the presence of stress; however, life events are unlikely to be homogenous, and the same event may hold very different meanings for two or more individuals¹⁷. Therefore, we examined the impact of NLE on children's pain sensitivity by considering maternal and child appraisal of events, rather than simply the presence of negative events. We also explored the impact of family life events in the context of acute laboratory pain. Laboratory pain studies allow the testing of hypotheses in a controlled fashion without potentially confounding factors such as variations in intensity or duration of clinical pain episodes or medical history of patients. Assessment of laboratory pain may provide a method for identifying children at risk of illness and pain behavior¹⁸, and in this sense, may be an indicator of real-life pain sensitivity. Boyce et al.¹⁸ demonstrated an association between family stressors and respiratory illnesses, but only in children with heightened cardiovascular reactivity to laboratory stressors. Laboratory pain reactivity has also been related to school absences¹⁹. Laboratory reactivity can thus help identify children who may be vulnerable to pain, within a standardized testing environment.

Thus, the purpose of the present study was to examine the association between maternal and child perceptions of the personal impact of NLE and children's response to three laboratory pain tasks (cold pressor, heat and pressure) in a non-clinical sample. Following Walker¹⁴, we also examined the impact of child sex and maternal somatization as potential moderators of this association, while controlling for child self-reported NLE and child age. Based on our own findings¹⁶ and that of Chambers et al.¹⁵, we expected to find sex differences in the relationship between children's pain responses and maternal perceptions of NLE such that these associations would be primarily evident among girls and not among boys.

Materials and Methods

Participants

The current sample was drawn from a larger sample of 240 children who participated in a study on the effects of sex and puberty on laboratory pain responses described previously.²⁰ Briefly, these findings indicated lower tolerance in females for pressure pain compared to males, with sex differences in pre-trial heart rate partially accounting for the difference. In addition, early pubertal children had greater pre-trial heart rate and less pain tolerance than those in late puberty across sex.

Children and their parents were recruited from a major urban area through mass mailing, posted advertisements, and classroom presentations. Four hundred eighty nine individuals were screened for eligibility by telephone. Seventeen children (3.5% of those screened) were excluded due to on-going acute or chronic illness or use of medications that would affect study outcomes. Of the 472 children and their parents (96.5%) invited to participate, 228 (48%) declined participation, mainly because of lack of interest or time. In the end, 244 healthy children (124 female; 50.8%) between 8 to 18 years ($M = 12.73$, $SD = 2.98$) and their parents were enrolled. The ethnic composition of the child sample was 40.2% Caucasian, 13.9% African-American, 9.8% Asian-American, 23.8% Hispanic, and 12.3% Other. From the larger dataset of 244 participants, parent data ($n = 47$) provided by fathers, legal guardians, aunts, grandparents, stepparents and older siblings were excluded from the analyses, because the present study focused on mother-child relationships; an additional nine participants were excluded because the nature of the relationship between the child and the respondent who completed the parent questionnaire was not specified. The decision to exclude fathers from the final sample was due to a small number of fathers in the current sample ($n = 35$) and the possibility that mothers and fathers differed in their reporting of negative life events. Also, 12 mother-child dyads with incomplete laboratory data or responses to the questionnaires were excluded.

The final sample consisted of 176 mother-child dyads. Children were evenly distributed by sex (50.6% male) with a mean age of 12.2 years ($SD = 2.7$, range 8–18), and nearly half (45.5%) were Caucasian, 19.9% were Latino, 13.6% were African American, 8.5% were Asian, and 12.5% were Other. Of the mother participants, most (69.9%) were married; 6.8% were separated; 11.9% were divorced; 3.4% were widowed; and 8.0% were single. Overall, mothers of child participants were highly educated. Among mothers 1.7% reportedly completed less than high school education; 8.5% graduated from high school; 29.5% completed at least one year of college or post-high school education; 31.3% completed an undergraduate degree; 29.0% had attended graduate or professional training. Ethnicity, age and income of mothers were not assessed.

Procedures

The procedure has been described in detail elsewhere^{20, 21}. Briefly, on the day of the laboratory session, child participants and their parents were escorted to separate quiet rooms and there was no contact between them until after the session was completed. Parents completed questionnaires either at home prior to the session or at the laboratory on the day of the session. Child participants completed questionnaires administered by an experimenter in a room adjacent to the laboratory. Child participants were then individually led into the laboratory where they were instructed on the use of the Visual Analog Scales (VAS) (described below) for rating task-related pain intensity and were then instructed about and exposed to three laboratory pain tasks (pressure, heat and cold pressor) (see descriptions below) presented in counterbalanced order. A two to three-minute resting period preceded and followed each pain task, with a 1-minute inter-trial resting period between trials. The presentation order (setting,

site of exposure) was counterbalanced across participants. Before the start of each pain task, participants were informed that they would experience moderate sensation, which may eventually be perceived as pain, and were instructed to continue with the trial for as long as they could, withdrawing if it became too uncomfortable and/or painful. All tasks were extensively piloted on volunteers in the targeted age range to ensure safety and acceptability and to determine the lowest level of stimulation that would allow sufficient variation in responses. The University of California, Los Angeles (UCLA) Institutional Review Board (IRB) approved all recruitment and study procedure, as well as consent and assent forms. Participants received a \$30 video store gift certificate and a T-shirt for their participation.

Laboratory Pain Tasks

Pressure Pain—The Ugo Basile Analgesy-Meter 37215 was used to administer focal pressure through a lucite point approximately 1.5 mm in diameter to the second dorsal phalanx of the middle or index finger of each hand. Four trials at two levels of pressure (322.5g and 465g) were conducted with an uninformed ceiling of 3 minutes. A comparable device has been used in healthy and clinical pediatric samples age 5–17 years without adverse effects^{22, 23}.

Heat Pain—The Ugo Basile 7360 Unit was used to administer a total of four trials of two infrared intensities (15, 20) of radiant heat 2" proximal to the wrist and 3" distal to the elbow on both volar forearms, with an uninformed ceiling of 20 seconds. Heat pain tolerance was electronically measured with an accuracy of 0.1 seconds. A contact heat task has been used in a sample of 6–17 years old without adverse effects²⁴.

Cold Pressor Task—A 38 cm wide, 71 cm long and 35 cm deep ice chest was fitted with a plastic mesh screen to separate crushed ice from a plastic mesh armrest in the 10° C water and a pump circulated the water through the crushed ice to prevent local warming about the hand. In one trial, participants placed the non-dominant hand, with the palm open and facing upward, in the water to a depth of 2" above the wrist for as long as they could with an uninformed three-minute ceiling. Only data from this trial was used in the current study. A second trial with a fixed, informed one minute ceiling was also administered, the results of which are reported elsewhere²⁵.

Measures

Questionnaires—*Life Experiences Survey* (LES-Section 1)²⁶ was administered to mothers to measure maternal negative life events (NLE). The LES is a 47-item scale that measures life events experienced in the past 12 months in adults, and their desirability/undesirability and impact on a 7-point scale of −3 (extremely negative) to +3 (extremely positive); thus, the format of the survey allows the respondent to determine the desirability or undesirability of the events experienced and for individualized ratings of the personal impact of the events experienced. Moderate internal consistency and reliability alphas have been reported (alpha range = .60–.79 over three years)²⁷. Negative life events have demonstrated stronger predictive links with health outcome measures than positive life events²⁸; thus, life stress was conceptualized in terms of negative life events score, which was derived by taking a simple unweighted sum of the negative impact ratings of life events experienced during the previous year.

The Coddington Life Events Scales (CLES)²⁹ measures life events experienced during the past 12 months by children and adolescents and was used to assess child negative life events (NLE). The child CLES (CLES-C, for ages 6–12) is a 35-item scale and the adolescent version (CLES-A, for ages 13 and above) is a 50-item scale. These scales were modified in the current study as follows: CLES items were used in conjunction with instructions and response options from Sarason et al. (1978), which assesses life events in the past 12 months and their impact on a 7-point scale of −3 (extremely negative) to +3 (extremely positive). As with the parent measure,

a stressful NLE score was calculated by taking a simple unweighted sum of the negative impact ratings of life events experienced during the previous year.

Symptom Checklist-90-Revised (SCL-90),³⁰ a widely used self-report measure for adults designed to assess nine psychological symptom dimensions, was administered to mothers. Only the 12-item somatization dimension was used (MSOM). Items to assess somatization include pain (e.g., headaches) and symptoms associated with strong autonomic mediation (e.g., nausea or upset stomach). Items are scored on a 5-point scale ranging from ‘not at all’ to ‘extremely.’ Good internal consistency (α range = .77–.90) and adequate test-retest reliability (range = .68–.83 over 10 weeks) have been reported for the nine dimensions³⁰.

Pain Measures

Pain Intensity—Immediately after each trial of the pain tasks, participants used a vertical sliding VAS anchored with 0 at the bottom indicating the least amount and 10 at the top indicating the greatest amount, in response to the instruction to rate “At its worst, how much pain did you feel during the task?” The scale also had color cues, graded from white to dark red, as well as a neutral face at the bottom and a negative facial expression at the top.

Pain Tolerance—Pain tolerance was defined as time in seconds elapsed from the onset of the pain stimulus to participants’ withdrawal from the stimulus.

Statistical analysis

Pain intensity ratings for the thermal and pressure tasks were highly correlated across the four trials within each task (r 's = .53–.89, $p < .001$); similarly, tolerance for the heat and pressure tasks was highly correlated (r 's = .61–.79, $p < .001$). Therefore, these data were averaged across trials yielding a mean heat intensity rating and a mean pressure intensity rating as well as a single tolerance value for the heat task and the pressure task.

The following bivariate analyses were initially conducted to examine relationships among the study variables prior to multivariate analyses: A standard probability level of .05 was used to evaluate the results of the bivariate analyses; for the multivariate analyses, Bonferroni corrections were utilized to control for possible Type I error due to multiple tests.

Multivariate analyses for mother-child dyads were conducted using the general linear model to separately analyze the association between the independent variables and the child pain variables. To conform to the assumptions of distribution normality, a logarithmic transformation of pressure tolerance was used to normalize model residuals. Modeling cold pressor tolerance and intensity indicated residual distributions that were non-normal; these residuals could not be normalized through a transformation of the dependent variables. Thus, logistic regression analyses were applied to analyze each of the cold pressor outcome measures after they were dichotomized (high vs. low) at empirically derived cut points detected through inspection of the distributions. These cut points were 4.99 for cold intensity and 70 seconds for cold tolerance. Independent variables for all models consisted of child sex, child age, maternal ratings of the adverse impact of negative life events (MNLE), maternal somatization scores (MSOM), and child ratings of the adverse impact of negative life events (CNLE). Also included in all multivariate models was the three-way interaction term for child sex*MSOM*MNLE, along with the three encompassed two-way interaction terms (sex*MSOM, sex*MNLE, MSOM*MNLE).

Because the adolescent and child life event forms differ in the number of items, scores from the two forms were separately standardized via z-scoring techniques and combined into a single CNLE score. All independent variables were simultaneously entered into the final models, and

a group-wise Bonferroni Type I error correction was applied to the multivariate tolerance and intensity models separately to derive a final two-tailed significance level of $\alpha = .017$. Twelve participants were excluded as outliers from the analysis due to MSOM ($n = 5$), MNLE ($n = 3$) or CNLE ($n = 4$) scores more than three standard deviations from the sample means, leaving a final sample size of $n = 164$ mother-child dyads.

Results

Descriptive Statistics

Table 1 shows the most commonly reported negative life events (NLE) for children and adolescents for the prior 12 months. Death of a family pet was the negative event most often reported by children, whereas failing to achieve something that was wanted was most reported by adolescents. The mean impact score displayed in Table 1 indicates how negatively each of the life events was rated by the respondent, ranging from slightly negatively to extremely negatively. For children, being hospitalized was the event with the most reported negative impact. Death of a close family member was rated as the most negative by adolescents.

Table 1 also shows the most commonly reported NLE by mothers for the prior 12 months. The most commonly reported negative event was a major change in financial status. The event with the most reported negative impact was the injury or illness of a close family member.

Bivariate Analyses

Initial analyses conducted to examine sex differences indicated that boys did not differ significantly from girls on their CNLE scores [$t(162) = 0.175, p = .86$], and a comparison of mothers of sons versus mothers of daughters indicated no significant differences in MNLE scores [$t(162) = -.196, p = .845$] or MSOM scores [$t(162) = -.92, p = .361$]. Boys also did not differ from girls on any of the pain outcome measures (i.e., cold pressor tolerance, cold pressor intensity, heat tolerance, heat intensity, pressure tolerance, and pressure intensity) (p -values ranged from .084 to .875). Within mother-child dyads, the correlation between the MNLE score and the CNLE score ($r = .074, p = .343$) and between MSOM and CNLE scores ($r = .091, p = .246$) were not significant, however a significant correlation was found between scores for MNLE and MSOM ($r = .318, p < .000$).

Table 2 displays bivariate correlations of MNLE, MSOM, and CNLE scores with the six laboratory pain outcome measures separately for boys and girls. In boys, MNLE scores were positively related to heat tolerance and inversely related to heat and pressure intensity. In girls, MNLE scores were inversely related to pressure intensity. The only other significant correlation was a negative relationship between MSOM scores and heat tolerance in girls. CNLE scores were not related to any of the outcome measures.

Multivariate Analyses

Results for the multivariate models with the mother-child dyads are shown in Table 3. For cold pressor tolerance and intensity, logistic regression did not reveal model significance. The overall amount of variance in pain outcomes explained in the four remaining models was 38% for heat tolerance, 20% for pressure tolerance, 18% for heat pain intensity and 18% for pressure pain intensity (see Table 3).

In these four remaining models, the beta coefficient for age differed significantly from zero—older age was associated with increased pain tolerance and lower pain intensity for both heat and pressure tasks. The mean heat intensity VAS score for children (aged 8–12 years) was 5.7, while for adolescents (aged 13–18 years) it was 4.15; heat tolerance for children was 8.8 seconds, and for adolescents was 14.23 seconds. The pressure intensity VAS score for children

was 5.5, and for adolescents was 4.5 (from 0 to 10). Pressure tolerance for children was 29.14 seconds, and for adolescents was 62.27 seconds. The beta coefficient for MSOM also differed significantly from zero, such that higher levels of mother somatization were associated with higher pressure intensity.

In three of the four models (heat tolerance, heat intensity, and pressure intensity) a significant child sex-by-MNLE interaction was found. These interactions indicated that the relationship between MNLE scores and pain outcomes differed between boys and girls. Figures 1–3 depict the observed means for girls versus boys and for high versus low MNLE scores for the three significant pain models. The low MNLE category included scores below the mean (mean = 5.29; SD = 5.61), and the high MNLE category included scores above the mean. As shown in Figure 1, higher MNLE scores were associated with increased heat tolerance in boys, but not for girls (Figure 1). Additionally, pain intensity ratings for the heat and pressure tasks were positively associated with MNLE scores girls, but negatively associated with MNLE scores in boys (Figures 2 & 3). Tests of the significant models revealed that the slope differed significantly from zero for boys for heat tolerance ($\beta = .31$, $p = .01$) and heat intensity ($\beta = -.29$, $p = .04$), whereas for girls the slope differed significantly from zero for heat intensity ($\beta = .38$, $p = .01$) and pressure intensity ($\beta = .44$, $p = .00$). Thus, higher ratings of the adverse impact of NLE in mothers were associated with lower pain reactivity among boys for heat tolerance and heat intensity, and higher pain reactivity among girls for the health and pressure tasks.

Discussion

The principal findings of the present study demonstrate the importance of examining the interdependent relationship between biological and sociocultural components of children's pain experiences. As hypothesized, maternal NLE experienced in the previous 12 months were related to children's laboratory pain responses, but not in the manner we predicted. Based on our prior findings¹⁶ and those of Chambers et al.,¹⁵ we expected that maternal perceptions of NLE would be associated with girls' laboratory pain responses but not with boys.' However, in multivariate analyses, we found that more negative perceptions of adverse life events in mothers was related to a number of increased pain responses in girls and *lower* pain responses in boys, after controlling for child age, children's NLE perceptions, and maternal somatization (see Table 3). In girls, maternal NLE were associated with greater heat and pressure pain intensity whereas in boys, maternal NLE were related to *lower* heat pain intensity and higher heat tolerance (see Figures 1 and 2).

The present findings are somewhat at odds with previous studies in non-clinical samples which demonstrated that maternal characteristics in the form of maternal anxiety sensitivity¹⁶ and mothers' responses to the cold pressor task were strongly related to girls' laboratory pain responses but unrelated to boys' pain responses¹⁵. On the other hand, the present findings are consistent with sex differences found elsewhere in the maternal and child stress literature. A similar interaction has been reported for boys and girls' stress responses to maternal post traumatic stress disorder symptoms (PTSS)³¹. Boys and girls displayed similar levels of stress when mothers reported low levels of PTSS. However, elevated PTSS in mothers was associated with a corresponding increase in stress symptoms in girls, and a *decrease* in stress symptoms in boys. These findings and those of the current study suggest that elevated maternal stress may be associated with distinct meanings and behaviors for girls versus boys.

Notably, sex differences in the association between maternal NLE and child pain responses were only found for heat and pressure pain and not for cold pressor pain. Differences may have resulted from distinct demands of the tasks. Divergent results for varying pain tasks and parameters are commonly reported, which likely reflects different pain processing pathways

20, 32, 33. The cold pressor task is thought to be most similar to acute clinical pain³⁴ and may be less generalizable to every-day pain experiences. In fact, cold and heat pain tasks appear to represent markedly different genetic and environmental influences, with environmental factors accounting for greater variance in heat than cold pain, and genetic factors accounting for greater variance in cold than heat pain³⁵. It is possible that the measure of maternal stress used in the present study represented an environmental influence in children's pain, and was thus more closely related to the heat than the cold pain task. By extension, it is possible that maternal stress in the form of negative events impacts on children through social factors. Through social learning processes, girls may model their mother's vulnerability to stress, psychological resources and coping when experiencing pain, while boys may model the wider culture's views on acceptable male responses to stress when experiencing pain.

One explanation for sex differences in response to maternal stress involves social roles. Boys are encouraged to emulate models of independence and toughness, such that the tougher the situation, the more stoic the boy needs to be³⁶, in contrast to girls who are encouraged to display openness and expressive vulnerability³⁷. These sex differences in social roles often translate as differences in stress-related appraisal, coping and behavior. Compared to boys, girls are more likely to rate life events as negative³⁸, use emotion-focused coping³⁷ and exhibit sensitivity to the stress of others³⁹. Within pain norms, boys are often pushed to withstand pain, while girls are free to report pain⁴⁰. In accord, we recently found in a subset of children from the present sample that higher self-reported masculinity in boys was associated with lower heat pain intensity³². However, it should be noted that when we conducted additional analyses including masculinity scores in our present models of maternal NLE, the results did not change.

Given socialized differences in reacting to stress and pain it is perhaps unsurprising that maternal perceptions of NLE were associated with opposite responses in boys and girls in the current study. It is possible that as mothers experience stress, boys are reinforced for increasing levels of stoicism, while girls imitate and are reinforced for modeling their mother's stress, which may generalize to displays of pain. Although the role of other family members was not tested in the present study, boys may imitate the responses of their fathers, who may respond to family stress in typically masculine ways, including displays of strength. These possibilities are speculative and require further testing including the examination of the impact of fathers' behavior and child pain. Such efforts to examine parent-child pain relationships based on the sex of the parent as well as the sex of the child are currently underway in our laboratory.

Our findings revealed that maternal variables such as somatization and reports of NLE were more consistently related to child pain than children's own reports of NLE. Mothers' somatization was related to higher pressure intensity across sex suggesting that children may model maternal distress responses under certain laboratory pain conditions. Child self-appraised NLE on the other hand, were unrelated to their own responses to laboratory pain. As reviewed by Scharff⁴¹, evidence of the influence of child-experienced NLE on pain complaints has been inconsistent. Some studies show no differences between children with chronic pain and controls in life events while others have reported adolescent patients with functional somatic complaints (e.g., chest pain, recurrent abdominal pain, limb pain) suffer more undesirable life events in the months before the onset of their symptoms. These divergent findings may be a reflection of children's appraisal of as well as their ability to cope with stressful situations. For instance, Walker et al.¹⁴ reported that maintenance of somatic symptoms was significantly related to life stress, but only in children with low levels of social competence.

The inconsistency of findings in relation to child reported NLE may also be due to the accuracy of child reports. The questionnaires assessing NLE asked about episodes in the last 12 months, and this time span may have proved challenging to younger children in the sample. Another

possibility is that children's laboratory pain behavior is modeled on their parent's stress and pain behavior, with events in the child's life playing less of a role in the child's pain responses. Reports from mothers and children in this study revealed substantial differences in the frequency and stressfulness of life events (see Table 1); indeed, child and maternal perceptions of negative events were unrelated in the present sample. Future work in this area might explore children's individual differences, such as coping style and social competence as moderators or mediators in the association between parental life stress and child pain responsivity.

In interpreting the results, certain methodological considerations should be taken into account. Our results do not indicate *how* maternal life events might influence children's laboratory pain, and the notion that this process occurs through gender specific socialization is speculative. Reliance on self-report measures of NLE raises the issue that there may be recall bias in children and mothers remembering and rating NLE experienced in the previous year. In addition, it is possible that life events occurring more than 12 months prior may have substantial long-term effects. Future research should also incorporate physiological responses to pain, including facial expressions. Sex differences in children's physiological responses to pain may reveal more about socialized pain sensitivity; we previously found that boys exhibited less autonomic arousal to laboratory pain tasks than girls²⁰. Further research may also examine developmental differences in children's responses to parental stress. Our sample included a wide age-range and it is possible that the salience and influence of events differed for younger versus older children. Generalizability of our findings may be limited in that all children were healthy, mothers were highly educated, and fathers were not included in the current sample. Finally, the present study was cross-sectional and thus causality cannot be inferred.

Despite these limitations, we conclude that the relationship between children's laboratory pain reactivity and maternal life stress deserves further consideration. Family background and stress may be of particular value in understanding clinical pediatric pain; the focus and content of intervention and prevention of pain in children may vary depending on parent, family and child characteristics. Although the current study was conducted in a non-clinical sample, our findings reinforce the idea that family variables are important in the assessment of child pain. These findings may also provide a step in understanding the distinct pain trajectories of men and women; parental reaction to pain and stress may set boys and girls along different pathways in their own experiences of pain and stress.

Acknowledgments

This study is dedicated to the memory of Cynthia Myers, Ph.D. The study was supported by 2R01DE012754, awarded by the National Institute of Dental and Craniofacial Research, and by UCLA General Clinical Research Center Grant MO1-RR-00865 (PI: Lonnie K. Zeltzer).

References

1. McGrath PA, Speechley KN, Seifert CE, et al. A survey of children's acute, recurrent, and chronic pain: validation of the pain experience interview. *Pain* Jul;2000 87(1):59–73. [PubMed: 10863046]
2. Perquin CW, Hazebroek-Kampschreur AA, Hunfeld JA, et al. Pain in children and adolescents: a common experience. *Pain* Jul;2000 87(1):51–58. [PubMed: 10863045]
3. Gatchel, RJ.; Turk, DC., editors. *Psychosocial factors in pain: critical perspectives*. New York: The Guilford Press; 1999.
4. Haavet OR, Straand J, Saugstad OD, Grunfeld B. Illness and exposure to negative life experiences in adolescence: two sides of the same coin? A study of 15-year-olds in Oslo, Norway. *Acta Paediatr Mar*; 2004 93(3):405–411. [PubMed: 15124848]
5. Johnson, JH.; McCutcheon, SM. Assessing life stress in older children and adolescents: Preliminary findings with the Life Events Checklist. In: Sarason, IG.; Spielberger, CD., editors. *Stress and Anxiety*. Vol. VII. Washington: Hemisphere Publishing; 1980. p. 111-125.

6. Poikolainen K, Kanerva R, Lonnqvist J. Life events and other risk factors for somatic symptoms in adolescence. *Pediatrics* Jul;1995 96(1 Pt 1):59–63. [PubMed: 7596724]
7. Singh H, Soni PK, Gill PJ, Kaur L. Stressful family life events and nonspecific somatic complaints in school children. *Indian Pediatr* Dec;1991 28(12):1483–1487. [PubMed: 1819571]
8. Walker LS, Greene JW. Negative life events and symptom resolution in pediatric abdominal pain patients. *J Pediatr Psychol* Jun;1991 16(3):341–360. [PubMed: 1890558]
9. Patterson JM, McCubbin HI. The Impact of Family Life Events and Changes on the Health of a Chronically Ill Child. *Family Relations* 1983;32:225–264.
10. Thomson B, Vaux A. The importation, transmission, and moderation of stress in the family system. *Am J Community Psychol* Feb;1986 14(1):39–57. [PubMed: 3962922]
11. Dohrenwend, BSBPD. Stressful life events: their nature and effects. New York: John Wiley & Sons; 1974.
12. Brown, GW.; Harris, TO. Life events and illness. New York: Guilford Press; 1989.
13. Liakopoulou M, Alifieraki T, Protagora D, et al. Recurrent abdominal pain and headaches. *European Child & Adolescent Psychiatry* 2002;11:115–122. [PubMed: 12369770]
14. Walker LS, Garber J, Greene JW. Somatic complaints in pediatric patients: a prospective study of the role of negative life events, child social and academic competence, and parental somatic symptoms. *J Consult Clin Psychol* Dec;1994 62(6):1213–1221. [PubMed: 7860819]
15. Chambers CT, Craig KD, Bennett SM. The impact of maternal behavior on children's pain experiences: an experimental analysis. *J Pediatr Psychol* Apr–May;2002 27(3):293–301. [PubMed: 11909936]
16. Tsao JCI, Lu Q, Myers CD, Turk N, Kim SC, Zeltzer LK. Parent and child anxiety sensitivity: Relationship to children's experimental pain responsivity. *Journal of Pain* 2006;7:319–326. [PubMed: 16632321]
17. Jackson Y, Warren JS. Appraisal, social support, and life events: predicting outcome behavior in school-age children. *Child Dev* Sep–Oct;2000 71(5):1441–1457. [PubMed: 11108106]
18. Boyce WT, Chesney M, Alkon A, et al. Psychobiologic reactivity to stress and childhood respiratory illnesses: results of two prospective studies. *Psychosom Med* Sep–Oct;1995 57(5):411–422. [PubMed: 8552730]
19. Tsao JC, Glover DA, Bursch B, Ifekwunigwe M, Zeltzer LK. Laboratory pain reactivity and gender: relationship to school nurse visits and school absences. *J Dev Behav Pediatr* Aug;2002 23(4):217–224. [PubMed: 12177567]
20. Lu Q, Zeltzer LK, Tsao JC, Kim SC, Turk N, Naliboff BD. Heart rate mediation of sex differences in pain tolerance in children. *Pain* Nov;2005 118(1–2):185–193. [PubMed: 16213093]
21. Tsao JC, Myers CD, Craske MG, Bursch B, Kim SC, Zeltzer LK. Role of anticipatory anxiety and anxiety sensitivity in children's and adolescents' laboratory pain responses. *J Pediatr Psychol* Jul–Aug;2004 29(5):379–388. [PubMed: 15187176]
22. Gil KM, Edens JL, Wilson JJ, et al. Coping strategies and laboratory pain in children with sickle cell disease. *Ann Behav Med* Winter;1997 19(1):22–29. [PubMed: 9603674]
23. Walco, GA.; Dampier, CD.; Harstein, G.; Djordjevic, D.; Miller, L. The relationship between recurrent clinical pain and pain threshold in children. In: Krane, EJ., editor. *Advances in Pain Research Therapy*. Vol. 15. New York: Raven Press; 1990. p. 333–340.
24. Meier PM, Berde CB, DiCanzio J, Zurakowski D, Sethna NF. Quantitative assessment of cutaneous thermal and vibration sensation and thermal pain detection thresholds in healthy children and adolescents. *Muscle Nerve* Oct;2001 24(10):1339–1345. [PubMed: 11562914]
25. Tsao JCI, Myers CD, Craske MG, Bursch B, Zeltzer LK. Impact of anxiety, sex and pubertal status on adolescents' laboratory pain responses. *J Pain* 2003;4(Suppl 1):16.
26. Sarason IG, Johnson JH, Siegel JM. Assessing the impact of life changes: development of the Life Experiences Survey. *J Consult Clin Psychol* Oct;1978 46(5):932–946. [PubMed: 701572]
27. Schmidt ME, Demulder EK, Denham SA. Kindergarten Social-Emotional Competence: Developmental Predictors and Psychosocial Implications. *Early Child Development and Care* 2002;172:451–462.

28. Sarason IG, Sarason BR, Potter EH 3rd, Antoni MH. Life events, social support, and illness. *Psychosom Med* Mar–Apr;1985 47(2):156–163. [PubMed: 4048362]
29. Coddington, RD. Coddington Life Events Scales (CLES) Technical Manual. North Tonawand: New York: Multi-Health Systems Inc; 1999.
30. Derogatis, LR. SCL-90-R Symptom Checklist-90-R. Mineapolis, MN: National Computer Systems, Inc; 1994.
31. Ostrowski SA, Christopher NC, Delahanty DL. Brief report: the impact of maternal posttraumatic stress disorder symptoms and child gender on risk for persistent posttraumatic stress disorder symptoms in child trauma victims. *J Pediatr Psychol* Apr;2007 32(3):338–342. [PubMed: 16717137]
32. Myers CD, Tsao JC, Glover DA, Kim SC, Turk N, Zeltzer LK. Sex, gender, and age: contributions to laboratory pain responding in children and adolescents. *J Pain* Aug;2006 7(8):556–564. [PubMed: 16885012]
33. Hastie BA, Riley JL 3rd, Robinson ME, et al. Cluster analysis of multiple experimental pain modalities. *Pain* Aug;2005 116(3):227–237. [PubMed: 15964682]
34. von Baeyer CL, Piira T, Chambers CT, Trapanotto M, Zeltzer LK. Guidelines for the cold pressor task as an experimental pain stimulus for use with children. *J Pain* Apr;2005 6(4):218–227. [PubMed: 15820909]
35. Nielson CS, Stubhaug A, Price D, OV. Individual differences in pain sensitivity: Genetic and environmental contributions. *Pain* 2008;136(1–2):21–29. [PubMed: 17692462]
36. Pollack WS. The “war” for boys: Hearing ‘real boys’ voices, healing their pain. *Professional Psychology: Research and Practice* 2006;37(2):190–195.
37. Matud MP. Gender differences in stress and coping styles. *Personality and Individual Differences* 2004;37(7):1401–1415.
38. Davis MC, Matthews KA, Twamey EW. Is life more difficult on Mars or Venus? A meta-analytic review of sex differences in major and minor life events. *Annals of Behavioral Medicine* 1999;21(1):83–97. [PubMed: 18425659]
39. Leadbeater BJ, Kuperminc GP, Blatt SJ, Hertzog C. A multivariate model of gender differences in adolescents’ internalizing and externalizing problems. *Dev Psychol* Sep;1999 35(5):1268–1282. [PubMed: 10493653]
40. Bendelow, G. Pain and Gender. Harlow, Essex: Prentice Hall/Pearson Education; 2000.
41. Scharff L. Recurrent abdominal pain in children: a review of psychological factors and treatment. *Clin Psychol Rev* 1997;17(2):145–166. [PubMed: 9140713]

Figure 1.
Interaction of child sex and mother negative life events score on child laboratory heat tolerance.

Figure 2. Interaction of child sex and mother negative life events score on child laboratory heat intensity rating.

Figure 3. Interaction of child sex and mother negative life events score on child laboratory pressure intensity rating.

Table 1

Most commonly reported negative life events for children, adolescents, and mothers, and their mean level of impact.

	N	N Boys	N Girls	Mean Impact Score (SD) *
Children (age = 8–12 years)				
Death of a pet	31	13	18	1.97 (0.87)
Failing to achieve something you really wanted	23	11	12	2.00 (0.85)
Death of a close family member	17	9	8	2.12 (0.70)
Hospitalization of a parent for illness or injury	12	7	5	2.21 (0.78)
Change in parent's job so (s)he spends less time at home	12	4	8	1.83 (0.69)
Start of a new problem between you and your parents	9	2	7	2.11 (1.05)
Being hospitalized for illness or injury	8	6	2	2.38 (0.52)
Divorce or separation of your parents	8	3	5	2.06 (0.78)
Start of a new problem between your parents	8	3	5	2.00 (0.93)
Hospitalization of a sibling for illness or injury	7	5	2	2.00 (1.00)
Adolescents (age = 13–18 years)				
Failing to achieve something you really wanted	13	8	5	1.81 (0.69)
Failing a grade in school	11	5	6	2.18 (0.75)
Breaking up with a boyfriend or girlfriend	11	4	7	2.00 (0.63)
Death of a close family member	9	6	3	2.22 (0.97)
Start of a new problem between you and your parents	9	4	5	1.72 (0.83)
Hospitalization of a parent for illness or injury	8	6	2	1.88 (0.64)
Parent's loss of job	7	3	4	1.57 (0.79)
Start of a new problem between your parents	6	5	1	1.57 (0.62)
Change in parent's job so (s)he spends less time at home	6	3	3	1.33 (0.52)
Mothers				
Major change in financial status	37	22	15	1.89 (0.88)
Serious illness or injury of close family member	36	17	19	2.19 (0.78)
Major change in sleep habits	35	20	15	1.57 (0.70)
Altered work situation (change in responsibilities/hours)	31	14	17	1.48 (0.72)
Death of a close family member	26	13	13	2.00 (0.80)
Minor law violation (traffic ticket, disturbing peace, etc.)	19	8	11	1.53 (0.77)
Major change in closeness of family member	18	8	10	1.94 (0.80)

	N	N Boys	N Girls	Mean Impact Score (SD) *
Change in husband's work (job loss or change)	18	4	14	1.83 (0.86)
Trouble with employer (suspension, demotion, etc.)	17	8	9	1.94 (0.90)
Major change in eating habits	17	8	9	1.59 (0.71)
Major change in usual type or amount of recreation	17	11	6	1.41 (0.62)

* An impact score of 1 corresponds to "slightly negative," 2 corresponds to "moderately negative," and 3 corresponds to "extremely negative." Impact scores for mothers were measured by the Life Events Survey; impact scores for children and adolescents were measured by the Coddington Life Events Scale.

Table 2
Bivariate correlations between negative life events, maternal somatization and child laboratory pain outcome measures for boys and girls.

		Cold		Heat		Pressure	
		Tolerance	Intensity	Tolerance	Intensity	Tolerance	Intensity
MNLE	Boys	.076	-.189	.337***	-.346***	.160	-.299***
	Girls	-.039	.014	-.156	.147	-.073	.245*
MSOM	Boys	.058	.012	.171	.009	.144	.070
	Girls	-.084	.081	-.267*	.006	-.042	.036
CNLE	Boys	.028	.037	.165	-.072	.137	-.138
	Girls	-.087	-.072	-.080	-.059	.071	-.069

Note: MNLE = Mother negative life events score; MSOM = Mother somatization score; CNLE = Child/Adolescent negative life events score.

* p<.05;
** p<.001

Table 3

Results of the multivariate analyses examining negative life events and maternal somatization as predictors of child laboratory pain: standardized β coefficients and p values (adjusted $\alpha = .017$).

	Cold Tolerance [*]	Heat Tolerance	Pressure Tolerance ^{**}	Cold Intensity [*]	Heat Intensity	Pressure Intensity
Age		0.57 (<.001)	0.44 (<.001)		-0.32 (<.001)	-0.30 (<.001)
Sex		0.26 (.023)	-0.07 (.575)		-0.21 (.106)	-0.12 (.344)
MNLE		0.12 (.179)	0.01 (.975)		0.01 (.989)	0.09 (.340)
MSOM		-.12 (.277)	-0.03 (.821)		0.30 (.018)	0.35 (.006)
CNLE		0.09 (.164)	0.12 (.088)		-0.10 (.168)	-0.14 (.064)
Sex * MNLE		0.31 (.009)	0.08 (.530)		-0.46 (.001)	-0.44 (.001)
Sex * MSOM		0.25 (.076)	0.06 (.718)		0.02 (.891)	0.12 (.447)
MNLE * MSOM		0.01 (.974)	0.07 (.670)		-0.32 (.060)	-0.37 (.032)
Sex * MNLE * MSOM		-.16 (.322)	0.02 (.904)		0.14 (.456)	0.03 (.865)
Model R ²	n. s.	.376	.195	n. s.	.179	.183

* Logistic model of dichotomous outcome (high vs. low)

** Logarithm of raw pressure tolerance duration.

Note: MNLE = Mother negative life events score; MSOM = Mother somatization score