Interactive Effects of Internalizing and Externalizing Problem Behaviors on Recurrent Pain in Children

Inka Vaalamo,1,2 MPsy, Lea Pulkkinen,1 PhD, Taru Kinnunen,1,3 PhD, Jaakko Kaprio,4 MD, and Richard J. Rose,5 PhD

1University of Jyväskylä, Finland; 2Psychiatric Clinic of Kankaanpää, Hospital District of Satakunta, Finland; 3Harvard Medical School; 4University of Helsinki and University of Oulu, Finland; and 5Indiana University

Objective: To examine, in children, relationships between self-reported recurrent pain and emotion regulation indicated by rated internalizing and externalizing problem behaviors and adjustment.

Method: Finnish 11–12-year-old schoolchildren (N = 414) completed a questionnaire measuring recurrent pain. Emotion regulation was assessed by a Multidimensional Peer Nomination Inventory, Teacher Rating Form. Relationships between recurrent pain and emotion regulation were examined in logistic regression analyses, after controlling for past injuries and chronic illnesses.

Results: Independent of injuries and chronic illnesses, externalizing and internalizing problem behaviors related to recurrent pain, and more so together than separately. Gender differences were found; constructive behavior associated with recurrent pain only in girls.

Conclusions: Low self-control of emotions, indicated by internalizing and externalizing problem behaviors, was related to pain in both boys and girls; high self-control of emotions, indicated by constructive behavior, associated with pain only in girls.

Key words: recurrent pain; emotion regulation; externalizing problem behavior; internalizing problem behavior.

Recurrent pain, repeated episodes of reported pain in the absence of identifiable etiology, is common among children and adolescents. Studies indicate that 12%–24% of school-age children report frequent headache (Beiter, Ingersoll, Ganser, & Orr, 1991; King, Wold, Tudor-Smith, & Harel, 1996; Kolip, 1997; Tamminen et al., 1991), 9%–19% report abdominal pain (Alfvén, 1993; Apley, 1975; Beiter et al., 1991; Ingersoll, Grizzle, Beiter, & Orr, 1993; Kolip, 1997; Tamminen et al., 1991), 13% report chest pain (Alfvén, 1993), and 32% report musculoskeletal pain (Mikkelsen, Salminen, & Kauhtainen, 1997a). Pain has been shown to seriously impair the daily functioning of children (Langeveld, Koot, & Passchier, 1999; Martin-Herz, Smith, & McMahon, 1999). Children with recurrent pain have more school absence and interference with social activities than children without pain (Martin-Herz et al., 1999).

Evidence links emotion regulation to the function of the autonomic nervous system (Cole, Fox,

Pulkkinen (1995) posits a model of emotional and behavioral regulation to explain recurrent pain in childhood (Figure 1). The model has been useful in explaining emotion regulation of people having physical symptoms (Kokkonen, Pulkkinen, & Kinnunen, 2001). It has been tested for over 30 years (Pitkänen, 1969; Pulkkinen, 1995; Pulkkinen, Kaprio, & Rose, 1999) and has shown predictive value over 20 years (Kokko & Pulkkinen, 2000; Laursen, Pulkkinen, & Adams, 2000; Hämäläinen & Pulkkinen, 1996; Pulkkinen, 1996; Pulkkinen & Pitkänen, 1994; Rönkä, Kinnunen, & Pulkkinen, 2000; Rönkä & Pulkkinen, 1995). Emotion regulation refers to the redirection, control, and modification of emotional arousal to enable an individual to function adaptively in emotionally arousing situations (Cicchetti, Ganiban, & Barnett, 1991). Emotion regulation helps maintain internal arousal within a manageable, performance-optimizing range. The model of emotional and behavioral regulation posits two orthogonal dimensions: expression versus inhibition of behavior, and low versus high self-control of emotions (Pulkkinen, 1995). These dimensions result from inhibitory and enhancing processes in the regulation of emotion and behavior: neutralization versus intensification of emotions and suppression versus activation of behavior. In the neutralization of emotion, an individual focuses attention on the aspects of the situation that help to regulate emotional arousal and its interpretation (Pulkkinen, 1995). Although emotion regulation often occurs once an emotion is elicited, an individual can also regulate his or her emotion by choosing situations for optimal emotional responding (Gross, 1999a).

In the intensification of emotion, an individual’s attention in a situation is on cues that intensify emotion. Intensification of emotion is facilitated by temperamental low reactivity, parental socialization, transitory state, and anticipation of emotional confrontation (Pulkkinen, 1995). In behavioral suppression, an emotional state, such as anxiety, is bound to situational cues but behavior for changing the situation is suppressed. The activation of behavior is seen in the lower threshold and latency and in the higher intensity of reaction. Combinations of these inhibitory and enhancing processes define four behavioral prototypes (A to D): (1) externalizing problem behavior, characterized by intense emotions and active behavior (Type A); (2) internalizing problem behavior, characterized by intense emotions and suppressed behavior (Type D), which is often referred to as emotional suppression in the literature; (3) constructive behavior, characterized by neutralized emotions and active behavior (Type B); and (4) compliant behavior, characterized by neutralized emotions and suppressed behavior (Type C). According to the model, internalizing and externalizing problem behaviors depict low self-control of emotions, and constructive and compliant behaviors depict high self-control of emotions. This interpretation has been confirmed by several studies. For example, the self-control rating scale (Kendall & Wilcox, 1979) correlates highly positively with teacher-rated constructive and compliant behaviors and highly negatively with hyperactivity-impulsivity, aggression, and anxiety (Lehto, Pulkkinen, & Juujärvi, 2000). Another study demonstrates continuity in low self-control of emotion from childhood to adulthood (Kokkonen & Pulkkinen, 1999). Low self-control of emotions in childhood was also related to long-term unemployment in adulthood (Kokko, Pulkkinen, & Puustinen, 2000) and to the lowered use of cognitive emotion-regulation strategies in adulthood (Kokkonen & Pulkkinen, 1999). Main
components of low self-control of emotions are inattentiveness and moodiness (Calkins, 1994; Gross, 1998, 1999b; Eisenberg, Fabes, Guthrie, & Reiser, 2000; Pope & Bierman, 1999; Pulkkinen, Kooistra, Tolvanen, & Mäkiäho, 2001; Rothbart & Putnam, in press). Low self-control of emotions in childhood has also been linked to self-reported physical symptoms, such as gastrointestinal problems, in adulthood (Kokkonen et al., 2001).

Emotional suppression, meaning inhibition of ongoing emotion-expressive behavior (Gross, 1998; Gross & Levenson, 1993), has been assumed to characterize the emotion regulation of those with recurrent pain (Alexander, 1950; Engel, 1959; Passchier, Goudswaard, Orlebek, & Verhage, 1988; Traue, 1995). There is evidence that recurrent pain relates to anxiety and depression (Ingersoll et al., 1993; Kristjánsdóttir, 1997; Martin-Herz et al., 1999; Mikkelsson, Sourander, Piha, & Salminen, 1997b), which, according to Pulkkinen’s (1995) model of emotion and behavioral regulation, indicates emotional intensification and behavioral suppression (Type D). In addition, some experimental studies have shown that those with recurrent pain are more likely to suppress emotional expression in stressful situations than those without pain (Traue, 1995; Traue, Gottwald, Henderson, & Bakal, 1985).

However, not all studies support the notion that people with recurrent pain would be more prone to suppress their emotions than those without pain. In fact, some studies indicate that recurrent pain is related to emotion expression rather than suppression (Gamsa & Vikis-Freibergs, 1991; Gross & John, 1995), and research with children and adolescents has shown that recurrent pain is associated with externalizing problem behaviors, such as aggression and inattention (Mikkelsson et al., 1997b). Other studies have not found this relation between pain and externalizing problem behavior (Cooper, Baden, Camfield, & Camfield, 1987; McGrath, Goodman, Firestone, Shipman, & Peters, 1983; Walker, Garber, & Greene, 1993; Walker & Greene, 1989; Wasserman, Whittington, & Riviara, 1988). These studies, however, were restricted to abdominal pain or headache. Further, these samples were clinically selected and may not be representative. Therefore, the central feature of emotion regulation in children with pain may not be the suppression of emotions, but rather intensified emotions or low self-control of emotions, reflected in both internalizing and externalizing problem behaviors.

According to Malatesta and Culver (1993), the relationship between emotion regulation and physical symptoms depends on gender (see also Burns et al., 1995). Ignoring the effect of gender when examining the relationship between emotion regulation and pain may be one factor explaining the contradictory results. The studies that have noticed the effect of gender show that boys with recurrent pain have more problems with emotion regulation and especially externalizing problem behavior (Andrasik et al., 1988; Beiter et al., 1991; Garrick, Ostrov, & Offer, 1988; Tamminen et al., 1991). However, not all the studies have found differences between boys and girls (Ingersoll et al., 1993; Mikkelsson et al., 1997b).

Conflicting findings concerning the association of recurrent pain with internalizing and externalizing problem behaviors make conclusions difficult to draw. Some of the limitations of previous research include nonrepresentative clinical populations, heterogeneous samples, common variance due to measuring both emotion regulation and pain with the same method, and failure to control identifiable etiologies for recurrent pain. In addition, there are a great number of studies examining internalizing and externalizing problem behaviors separately in relation to pain, not allowing the study of their common effects on the likelihood for pain compared to the effects of each of them separately. These two problem behaviors have been shown to be highly related (Knox, King, Hanna, Logan, & Ghaziuddin, 2000; Zoccolillo, 1993). According to Pulkkinen’s (1995) model of emotional and behavioral regulation, low self-control of emotion underlies both problems. To improve on previous studies, we have taken the following steps: (1) studied the interacting effects of internalizing and externalizing problem behaviors; (2) used a theoretical framework to tie the different results together; (3) used a representative, nonclinical population; (4) taken heterogeneity of the sample into account by examining gender differences; (5) measured emotion regulation and pain by different methods; (6) taken different kinds of pain reports into account; and (7) controlled for chronic illnesses and injuries in order to avoid taking into account pain with known physical etiology.

The purpose of this study was to examine the relationship between recurrent pain and emotion regulation. We hypothesized that low self-control of emotions, indicated by both internalizing and externalizing problem behaviors (Pulkkinen, 1995) would be related to recurrent pain (Beiter et al., 1991; Ingersoll et al., 1993; Mikkelsson et al., 1997b). Furthermore, we hypothesized that the re-
relationship between recurrent pain and externalizing problem behavior would be stronger for boys than for girls (Andrasik et al., 1988; Beiter et al., 1991; Garrick et al., 1988; Tamminen et al., 1991).

Method

Participants

The data reported here were collected from an ongoing longitudinal study of behavioral development and health habits, FinnTwin12, which will ascertain and study ~2,800 twin pairs from five consecutive and complete birth cohorts of Finnish twin children. Data for this analysis were collected through self-report questionnaires administered at baseline to a cohort born in 1984 and then tested in 1996, at ages 11–12. Twins were identified from the nation's Central Population Registry as part of Finnish Twin Cohort studies (Kaprio, Koskenvuo, & Rose, 1990); 87% of the twin families contacted were willing to participate in the study and provided a written, informed consent to participate in the questionnaire study. Permission to contact the school attended by the twin children, to carry out teacher ratings, was obtained from 92.7% of these families. Given the population-based assessment and very high response rates, our sample is representative of Finnish children of this age.

Although the study population consists of twins, this analysis ignores their twin status and considers them as individuals drawn from the population. To avoid statistical issues arising from having two individuals from each family in the data set, the study sample was formed by randomly selecting one co-twin from each twin pair. The sample consisted of 414 children, 196 girls and 218 boys. Age of the children ranged from 10.9 to 12.2 years with a mean of 11.4 years ($SD = .29$). On average boys ($M = 11.46, SD = .28$) were slightly older than girls ($M = 11.36, SD = .29, t[411] = 3.38, p = .001$).

Measures

Emotion Regulation. A multidimensional inventory of children’s social behavior was developed for peer nomination (MPNI; the Multidimensional Peer Nomination Inventory; see Pulkkinen, 1982; Pulkkinen et al., 1999) within the framework of the model of emotional and behavioral regulation. It was designed to assess the behavioral prototypes of the model. A 37-item Teacher Rating Form (TR-MPNI), used in this study, was developed from the MPNI (Pulkkinen et al., 1999).

The TR-MPNI items were presented in the form of statements (e.g., “Cannot concentrate in anything”). The teachers were asked to rate each twin on every item on a four-point scale where 0 = does not apply; 1 = applies sometimes, but not consistently; 2 = certainly applies, but not in a pronounced way; 3 = applies in a pronounced way. A factor analysis (principal axis method and varimax rotation) of the structure of the TR-MPNI resulted in three main factors called behavioral problems (here: externalizing problem behavior), adjustment, and emotional problems (here: internalizing problem behavior), as in the previous analysis by Pulkkinen et al. (1999). The original names of the factors refer to the framework model; the names used here are synonymous constructs commonly used in literature. Subscales of these factors and their coefficients alphas for girls and boys, respectively, were as follows: Hyperactivity-Impulsivity, .91 and .95; Aggression, .84 and .91; Inattention, .80 and .85; Constructive behavior, .81 and .87; Compliant Behavior, .38 and .74; Social Activity, .64 and .67; Depression, .73 and .75; and Social Anxiety, .75 and .69. The TR-MPNI has been shown to be reliable and has both concurrent and discriminative validity (Pulkkinen et al., 1999).

In the Finnish public school system, children under age 13 attend primary schools, where all classes have a classroom teacher; the classroom teacher instructs the children in most school subjects and knows the children well, usually teaching the same children for about 3 years. In some schools, children have the same classroom teacher from the beginning of primary school (at age 7) until its end (at age 13). For this study, the mean size of the classes was 25 children ($SD = 7.20$); the mean school size was 247 children ($SD = 175$).

Recurrent Pain. Items measuring recurrent pain were based on a World Health Organization (WHO) survey on schoolchildren’s health and health-related behaviors (King et al., 1996) and a structured pain questionnaire (Mikkelsson, 1998; Mikkelsson et al., 1997a,b). The items classify pain symptoms during the previous 3 months by body area and frequency. The following body areas were distinguished: neck and shoulders; low back; lower extremities; upper extremities; chest, upper back, and buttocks; headache and abdominal pain were included also. The concerned body area was identi-
fied in a schematic to help children distinguish each named area. A 5-level frequency classification (almost daily, more than once a week, once a week, once a month, seldom, or never) was used in the pain questionnaire (Mikkelsson, 1998). A dichotomized variable was formed to reflect whether each child did or did not report weekly pain, and test-retest reliability of this dichotomized variable is satisfactory, over a brief time-interval, ($\kappa = 0.9$) (Mikkelsson 1997a). The concurrent validity of the questionnaire, against interview, has been studied with an observed agreement of 86%, ($\kappa = 0.67$.)

**Pain Due to Injury.** If the children had experienced pain due to injury, they were asked to mark the area of the injury on the pain schematic with a different color.

**Long-Term Illnesses.** Parents were asked if their children ever had asthma, history of febrile or other seizures (with lapses of consciousness or convulsions), or whether they have had other chronic diseases. The parents were asked also if their children took any medication for chronic disease. From these parental reports, a variable was formed to classify children into those who ever had long-term illness and those who used medications for chronic disease. A history of seizures and other chronic diseases was not included in this variable, because these diseases did not correlate with recurrent pain.

**Data Analyses**

Analyses were conducted in SPSS, with $p$ value < .05 considered statistically significant. Chi-square was used to study the differences in pain reports among girls and boys. Mann Whitney $U$ test was used to study differences in frequencies of emotion regulation in girls and boys. Spearman rank correlations were computed to examine interrelationships between pain variables.

We analyzed the hypothesis relating recurrent pain to low self-control of emotions by multivariate logistic regression analysis. Odds ratios (ORs) with 95% confidence intervals (95% CIs) were used to measure risk for increases in recurrent pain as the variable increased one standard deviation. Continuous variables (emotion regulation) were standardized before analysis. Pain due to injuries and long-term illnesses were accounted for, by entering them first in the model. We put the interaction effects of emotion regulation variables in the models after their main effects. In detailed analyses of interaction effects, one variable was divided into three categories, and logistic regression analyses were then performed on the other unclassified variable across each of the three categories; approximately a third of the participants were included in each category, so that the first category included those with lowest scores on the variable in question; the second included those with intermediate scores, and those with the highest scores on the variable formed the third category. Finally, cross-tabulations with adjusted standardized residuals were used to reveal the proportions of children reporting recurrent pain according to these classified variables.

We analyzed the hypothesis of gender differences in the relationship of pain to emotion regulation with logistic regression. We computed interaction effects of gender and emotion regulation on pain, while controlling for long-term illnesses and pain due to injuries.

**Results**

**Descriptive Statistics**

Almost half of the children (44%) reported frequent (at least weekly) pain (Table I). Pain was most frequently reported in lower extremities. Chi-square analyses revealed no significant gender differences between those with and without frequent pain episodes. With regard to single pains, however, boys reported more pain in lower extremities than girls, and girls had more chest pain than boys (Table I). Spearman correlations showed that pains in different parts of the body were related, the median cor-

<table>
<thead>
<tr>
<th>Pain</th>
<th>All</th>
<th>Girls</th>
<th>Boys</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All pain</td>
<td>43.5</td>
<td>40.4</td>
<td>46.3</td>
<td>1.39</td>
</tr>
<tr>
<td>Neck and shoulders</td>
<td>12.6</td>
<td>11.5</td>
<td>13.6</td>
<td>0.38</td>
</tr>
<tr>
<td>Lower extremities</td>
<td>23.7</td>
<td>15.3</td>
<td>31.2</td>
<td>14.10***</td>
</tr>
<tr>
<td>Upper back</td>
<td>6.2</td>
<td>6.9</td>
<td>5.6</td>
<td>0.28</td>
</tr>
<tr>
<td>Low back</td>
<td>5.2</td>
<td>4.2</td>
<td>6.1</td>
<td>0.69</td>
</tr>
<tr>
<td>Buttocks</td>
<td>3.2</td>
<td>2.1</td>
<td>4.2</td>
<td>1.40</td>
</tr>
<tr>
<td>Upper extremities</td>
<td>5.7</td>
<td>3.7</td>
<td>7.4</td>
<td>2.66</td>
</tr>
<tr>
<td>Chest</td>
<td>3.2</td>
<td>1.1</td>
<td>5.1</td>
<td>5.40*</td>
</tr>
<tr>
<td>Abdominal</td>
<td>12.3</td>
<td>12.8</td>
<td>11.9</td>
<td>0.08</td>
</tr>
<tr>
<td>Headache</td>
<td>19.1</td>
<td>19.4</td>
<td>18.8</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Total N varies from 402 to 414; for girls, N varies from 188 to 196; for boys, N varies from 214 to 218.

* $p < .05$.

**Table I.** Percentage of Different Pains Reported by Girls and Boys

\[***p < .001.\]
relation being .29 ($p = .000$). Pain due to injuries was reported by 34% of the children, and parents reported that 15% had long-term diseases (asthma, convulsions or muscular contractions, long-term medication).

Mann-Whitney $U$ tests were used to explore gender differences in teacher-reported emotion regulation. Boys were rated as having more externalizing problem behavior than girls ($Mann-Whitney U = 12698; p = .000$). Conversely, girls were rated as better adjusted than boys ($Mann-Whitney U = 14462; p = .000$).

**Relationship Between Low Self-Control of Emotions and Pain**

We performed a series of logistic regression analyses to examine the association of emotion regulation with recurrent pain, while controlling for pain due to injuries and long-term illnesses. Low self-control of emotions was related to recurrent pain in the general model. Both internalizing problem behavior and externalizing problem behavior were associated with pain, independently of injuries and long-term illnesses (see Table II). There was an interaction effect of internalizing and externalizing problem behaviors on pain. To assess the nature of the interaction effect, externalizing problem behaviors were divided into three classes, and logistic regression analyses of internalizing problem behaviors were then performed with each of these three classes. Results revealed that internalizing problem behaviors related to pain only in the context of externalizing problem behaviors. If internalizing problem behaviors were one standard deviation above the mean, the risk for recurrent pain nearly doubled in children rated to have the most externalizing problem behaviors ($OR = 1.89, 95\% CI = 1.22, 2.84, p = .004$). Analogously, when internalizing problem behaviors were divided into three classes, externalizing problem behaviors were associated with pain only at the highest level of internalizing problem behaviors. In this case, the increase was over two-fold, when externalizing problem behaviors increased one standard deviation ($OR = 2.06, 95\% CI = 1.29, 3.29, p = .003$). The interaction effect was further examined using cross-tabulation, and children having both abundant externalizing and internalizing problem behaviors were more likely to suffer from recurrent pain than children with moderate or low degrees of either or both problems (Table III).

The probability of children having recurrent pain is illustrated in Figure 2. Children had a greater probability of having pain if they had both internalizing and externalizing problem behaviors one standard deviation above the average (see externalizing problem behavior line 1.0 $SD$ above the mean and 1.0 $SD$ point in the horizontal axis in Figure 2) compared to those with average internalizing and externalizing problem behaviors score (see mean externalizing problem behavior line and 0 $SD$

---

**Table II. Multiple Logistic Regression Coefficients of Internalizing and Externalizing Problem Behaviors to Recurrent Pain While Controlling for Injuries and Long-Term Illnesses**

<table>
<thead>
<tr>
<th>Model 1a</th>
<th>Logistic coefficient</th>
<th>SE of coefficient</th>
<th>Standardized odds ratio*</th>
<th>95% CIs</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injuries</td>
<td>-0.296</td>
<td>0.237</td>
<td>0.74 (1.35)</td>
<td>0.59, 0.94</td>
<td>.013</td>
</tr>
<tr>
<td>Long-term illnesses</td>
<td>0.101</td>
<td>0.160</td>
<td>1.11</td>
<td>0.81, 1.51</td>
<td>.526</td>
</tr>
<tr>
<td>Internalizing problem behavior</td>
<td>0.258</td>
<td>0.114</td>
<td>1.29</td>
<td>1.03, 1.62</td>
<td>.024</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injuries</td>
<td>-0.257</td>
<td>0.118</td>
<td>0.77</td>
<td>0.61, 0.98</td>
<td>.030</td>
</tr>
<tr>
<td>Long-term illnesses</td>
<td>0.064</td>
<td>0.158</td>
<td>1.07</td>
<td>0.78, 1.45</td>
<td>.684</td>
</tr>
<tr>
<td>Externalizing problem behavior</td>
<td>0.250</td>
<td>0.112</td>
<td>1.28</td>
<td>1.03, 1.60</td>
<td>.026</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injuries</td>
<td>-0.260</td>
<td>0.121</td>
<td>0.77 (1.30)</td>
<td>0.61, 0.98</td>
<td>.032</td>
</tr>
<tr>
<td>Long-term illnesses</td>
<td>0.128</td>
<td>0.165</td>
<td>1.14</td>
<td>0.82, 1.57</td>
<td>.439</td>
</tr>
<tr>
<td>Internalizing problem behavior</td>
<td>0.226</td>
<td>0.125</td>
<td>1.25</td>
<td>0.98, 1.60</td>
<td>.070</td>
</tr>
<tr>
<td>Externalizing problem behavior</td>
<td>0.220</td>
<td>0.119</td>
<td>1.25</td>
<td>0.99, 1.57</td>
<td>.065</td>
</tr>
<tr>
<td>Int.*Ext.</td>
<td>0.368</td>
<td>0.136</td>
<td>1.45</td>
<td>1.11, 1.89</td>
<td>.007</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.073</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Reciprocal values for standardized odds ratio values that are less than 1 are presented in parentheses.
point in the horizontal axis in Figure 2); the probabilities were about 85% and 58%, respectively.

The associations of the subscales of internalizing and externalizing problem behaviors were examined after influences of long-term illnesses and injuries were controlled. Hyperactivity-Impulsivity (OR = 1.26, 95% CI = 1.01, 1.57, p = .040), Inattention (OR = 1.26, 95% CI = 1.01, 1.57, p = .039), and Depression (OR = 1.37, 95% CI = 1.09, 1.72, p = .007) were related to pain independently of injuries and long-term illnesses. Depression and aggression had an interaction effect on pain (p = .019): only in the most aggressive children was depression associated with pain. As depression increased one standard deviation, risk for recurrent pain doubled in the children rated most aggressive (OR = 2.14, 95% CI = 1.35, 3.40, p = .001). Correspondingly, only among the most depressed children was aggression related to pain. As aggressiveness increased one standard deviation above the mean, the risk for recurrent pain increased one and a half times in the context of elevated depressive symptoms (OR = 1.48, 95% CI = 1.01, 2.18, p = .044). There was an interaction effect for hyperactivity-impulsivity and depression on pain (p = .009), which paralleled the interaction effect of depression and aggression: Only in the most depressed children was hyperactivity-impulsivity related to pain (OR = 1.86, 95% CI = 1.21, 2.86, p = .005). Correspondingly, only among children rated most hyperactive-impulsive was depression associated with pain (OR = 2.28, 95% CI = 1.42, 3.67, p = .0007). Thus, it seems that the internalizing problem behavior of depression and the externalizing problem behaviors of aggression and impulsivity have the strongest relationship with pain.

### Gender Effects

No effects were found in examining interaction effects of gender with internalizing and externalizing problem behaviors. There was a significant interac-

---

Table III. Percentage of Children Reporting Recurrent Pain According to Teacher-Rated Internalizing and Externalizing Problem Behaviors (N = 174)

<table>
<thead>
<tr>
<th>Internalizing Problem Behaviors</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Externallizing Problem Behaviors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>13 (22)</td>
<td>8 (13)</td>
<td>8 (14)</td>
</tr>
<tr>
<td>Moderate</td>
<td>16 (27)</td>
<td>9 (15)</td>
<td>8 (14)</td>
</tr>
<tr>
<td>High</td>
<td>12 (21)</td>
<td>10 (17)</td>
<td>18 (31)</td>
</tr>
</tbody>
</table>

*aSignificantly greater than expected.*

---

Figure 2. Predicted probability for recurrent pain as the function of internalizing and externalizing problem behaviors.
to the model of emotion and behavioral regulation (Pulkkinen, 1995), low self-control of emotions resulting from intensification of emotional experience seems to characterize the emotion regulation of children reporting pain. This is consistent with previous results suggesting that the strength of the emotional response is the central feature of emotion regulation in adults with somatic complaints (Burns et al., 1995; Gross & John, 1995). We found that inattentiveness was related to both depression and aggression, thus confirming that internalizing and externalizing problem behaviors have low attentional control in common, which is an integral part of emotion regulation (Calkins, 1994; Eisenberg et al., 2000; Gross, 1998, 1999b; Pope & Bierman, 1999; Pulkkinen et al., 2001; Rothbart & Putnam, in press).

The relationship between low self-control of emotions and pain may be explained in many ways. First, internalizing problems may lead to pain through sympathetic activity and muscle constriction (Gross, 1998; Gross & Levenson, 1993, 1997; Pennebaker, 1985, 1991; Traue, 1995). Second, pain can, itself, act as a stressor lowering life satisfaction (Langeveld et al., 1999) and increasing the likelihood for aggression (Anderson, Anderson, Dill, & Deuser, 1998; Berkowitz, 1993; Gamsa & Vikis-Freibergs, 1991). Animal studies have shown that, as a result of painful stimulation, animals start to fight or flee (Berkowitz, 1993). Correspondingly, the more pain humans report, the more likely they report feeling angry and turn to aggressive behavior (Gamsa & Vikis-Freibergs, 1991). In experimental work, participants feel more resentment in painful situations (Anderson et al., 1998) and are more willing to harm others (Berkowitz, Cochran, & Embree, 1981) than in neutral situations.

Third, pain and emotion regulation may also share a common etiology. Serotonin metabolism could be the basis for low self-control of emotions and pain, as it has been associated with both phenomena (France et al., 1987; Jensen et al., 1994; Lund, 1994). From the psychological perspective, negative affectivity could be associated with reports of high levels of negative feelings, as well as physical symptoms (Deary, Scott, & Wilson, 1997; Watson & Pennebaker, 1989). Similarly, physiological reactivity levels may predispose to specific emotions and ways of emotion regulation (Kagan, 1992, 1998) as well as to muscle constriction and thus to pain (Traue, 1995). Given our results, one might think that children who have difficulties neutraliz-
ing their emotional arousal may have similar problems in diminishing their experience of pain. They may be sensitive to both negative feelings and painful physical experiences and may intensify the experience of both.

These different explanations of the relationship between pain and emotion regulation need not be mutually exclusive; the relationship may be bidirectional. It could be, for example, that pain acts as a stressor to increase emotional turmoil of a child, which, in turn, lowers the threshold for pain (Kristjánsdóttir, 1997). Emotional turmoil, itself, may strain the coping capacity of a child and thus increase the stress experienced. This may activate the sympathetic nervous system, which may increase muscle tension and pain. Consequently, pain and low self-control of emotions may exacerbate one another and lead to a vicious circle. For those with biological or psychological susceptibilities to pain and negative feelings (serotonin metabolism, negative affectivity, physical reactivity), the vicious circle may be particularly likely.

Contrary to previous research (Andrasik et al., 1988; Beiter et al., 1991; Garrick et al., 1988; Tamminen et al., 1991), boys with recurrent pain in this study had no more externalizing problem behaviors than did girls, perhaps reflecting methodological and sampling differences. Gender differences were found: constructive behavior associated with recurrent pain only in girls. Thus, in addition to low self-control of emotions, constructive behavior may also increase the risk for recurrent pain in girls. The optimality of emotion regulation seems to be central with regard to well-being (Cole, Michel, & Teti, 1994; see also Eisenberg et al., 1997). Research on the relationship between adjustment and pain is limited, as adjustment has been identified mainly from a negative perspective. Most studies have found that children with pain have more adjustment difficulties than children without pain (Beiter et al., 1991; Ingersoll et al., 1993; Mikkelsson et al., 1997b). However, one study consistent with our results found that high sociability among 5-year-old children predicted later headache (Aromaa, Rautava, Helenius, & Sillanpää, 1998). Constructive behavior, occurring as excess caring of others and overconscientiousness, could result in neglect of one's own needs and difficulties in self-assertiveness. In turn, this may lead to an accumulation of stressors, which may increase muscle constriction and pain.

We note some limitations of this study. First, its cross-sectional nature does not allow causal inferences. In the future, research should be directed to understanding underlying mechanisms between pain and low self-control of emotional behavior and between pain and constructive behavior in girls. Genetically informative research designs, including pairwise analyses of the twin data here described, will be particularly useful to estimate genetic and familial environmental covariance. Second, variables that mediate the relationship between pain and emotion regulation were not included in this study. These variables might include a parenting style that causes stress in a child and does not support the development of emotion regulation. Third, emotion regulation was measured solely with teacher ratings. Teachers see only part of children's lives and may not recognize covert symptoms of anxiety and depression. On the other hand, teacher ratings are a reliable method to measure overt problems of emotion regulation (Cole, Martin, Lachlan, Henderson, & Harwell, 1998; Puukkinen et al., 1999). Fourth, reliability of the compliance scale for girls was rather low, which makes the results for that scale uncertain.

Fifth, pain was measured according to its location and frequency, but its chronicity and severity were ignored. It has been shown, however, that recurrent pain is a fairly permanent symptom in childhood and adolescence (Choquet & Menke, 1987; Mikkelsson et al., 1997a). Sixth, pain measurement relied on children's retrospective observations of pain. Consequently, memory problems or tendencies to overemphasize or minimize symptoms may reduce the reliability of results. However, self-reports are the only reliable method to measure pain due to its subjective nature (McGrath, 1996; Savedra & Tesler, 1989; Varni, Walco, & Katz, 1989). Diary methods could have made the measurement more valid, as they are less dependent on memory (see Hunfeld, Deuervaarder, Hazebroek, van Suijlekom-Smit, & van der Wouden, 1997; Metsähonkala, Sillanpää, & Tuominen, 1997). Seventh, it is possible that pain reported in this study had a known organic etiology, as medical examination could not be arranged. However, the etiology of pain has not been shown to affect the relationship of pain and internalizing and externalizing problem behaviors (Walker et al., 1993; Walker & Greene,
In girls, menstruation was not taken into account as a possible cause of pain. However, pain due to menstruation would occur more rarely than once a week, and in this study, the criterion for recurrent pain was at least weekly occurrence. Further, only 5% of the girls in this sample had reported the onset of menstruation.

The twin status of the participants is not likely to affect the generalizability of our results: A study by Gjone and Novik (1995) found no differences between twins and other children with regard to externalizing problem behavior and only slight differences with regard to internalizing problem behavior. With regard to other age groups, the relationship between different problems and pain might be clearer among older children, especially boys (Andrasik et al., 1988). In adults, also, there is much evidence that pain relates to low self-control of emotions (Bru, Mykletun, & Svebak, 1993; Gamsa & Vikis-Freibergs, 1991; Schermelleh-Engel, Elерт, Moosbrugger, & Frank, 1996).

The results of this study suggest that both internalizing and externalizing problem behaviors should be taken into account in clinical examinations of recurrent pain in childhood. Problems of emotion regulation associated with recurrent pain may indicate the need for clinical intervention, as the co-occurrence of emotional dysregulation and pain has been shown to increase the persistence of both problems (Ferdinand & Verhulst, 1995). Physicians evaluating adolescents with recurrent pain should assess internalizing and externalizing problem behaviors and refer to mental health professional for further evaluation as needed.

Acknowledgments

Data collection was supported by the National Institute on Alcohol Abuse and Alcoholism (AA-09203 and AA-00145) and by the Academy of Finland, Finnish Centre of Excellence Programme no. 40166. We thank Asko Tolvanen, Risto Hietala, and Ari Mäkiäho for their statistical and computing aid and advice. We also thank Marja Mikkelson, MD, for her contribution to the measurement of pain.

Received March 13, 2000; revisions received November 20, 2000; accepted July 31, 2001

References

tions from the study of high-risk populations to understanding the development of emotion regulation. In J. Garber & K. A. Dodge (Eds.), *The development of emotion regulation and dysregulation* (pp. 15–48). Cambridge: Cambridge University Press.


