Pain Reactivity and Somatization in Kindergarten-Age Children

Elizabete M. Rocha, MSc, Kenneth M. Prkachin, PhD, Sherry L. Beaumont, PhD, Cindy L. Hardy, PhD, and Bruno D. Zumbo, PhD

University of Northern British Columbia

Objective To evaluate predictors of somatization and pain reactivity in childhood.

Methods Facial expressions of children undergoing inoculation were scored for pain reactivity. Measures of temperament, pain experience, pain models, parental behavior, and parental ability to decode pain were examined for their ability to predict pain reactivity and somatization in a structural modeling analysis. Results Pain reactivity was associated positively with parental reports of their child's somatization. Child temperament, previous negative experiences with medical procedures, and maternal responses to their children's pain were positively associated with pain reactivity. Conclusions Temperament and pain experience may play a role in children's pain reactivity, and reactivity may contribute to the development of somatization. Although the model that guided the analysis proved to be a reasonable description of the outcomes, several anticipated relationships were not significant. We discuss implications for a refined model of somatization and for early identification and prevention.

Key words pain; reactivity; facial expression; temperament; somatization; structural modeling.

Somatization refers to high rates of complaint about bodily disturbances, discomfort, and dysfunction out of proportion to pathology (Garralda, 1996). Estimates of its prevalence are difficult to establish due to different standards for assessment. Somatization disorder as defined in DSM-IV is rarely diagnosed in children (Campo & Fritsch, 1994). Garber, Walker, and Zeman (1991) provided a prevalence estimate of 1% in a community sample of children and adolescents, whereas Offord et al. (1987) characterized approximately 4.5% of boys and 10.7% of girls in the 12- to 16-year-old range as displaying a somatization syndrome. Patterns of somatization are thought to develop throughout childhood and to remain fairly stable in adulthood (Campo & Fritsch, 1994; Garralda, 1996; Mechanic, 1980). Identifying factors that play a role in its development is important in advancing understanding, prevention, and management of somatization.

Pain reactivity refers to the extent of change in pain-related behaviors following a standard noxious experience. Although pain reactivity can be assessed by evaluating a number of behaviors, facial expressions of pain provide considerable advantages. Experimental and clinical studies have identified a limited set of facial actions that correlate with pain, vary in intensity, appear to be sensitive to variations in pain experience, and can be observed readily in the natural environment (Craig, Prkachin, & Grunau, 2001). There is evidence of replicable individual differences in pain reactivity as assessed by facial expression in adults (Prkachin, 1992) and children (Barr, Boyce, & Zeltzer, 1994).

The goal of this study was to identify predictors of pain reactivity and somatization in kindergarten-age children undergoing routine diphtheria-pertussis-tetanus-polio (DPTP) inoculations. The study of responses to inoculation at this age presents a number of advantages. In most jurisdictions, children entering kindergarten must undergo a DPTP booster; therefore, it is a convenient way of recruiting a broadly representative sample. Inoculations have a clearly defined stimulus and specific time of onset and are generally considered painful to children at...
this age. Moreover, this inoculation occurs just prior to beginning school. Consequently, children have been exposed largely to family influences and comparatively less to the social demands associated with school performance and peer relationships that may exacerbate or complicate somatization processes.

We used structural equation modeling to assess and refine a model of expected relationships. Structural modeling terminology distinguishes “upstream” variables, which can be thought of as predictors, from “downstream” variables, which can be thought of as outcomes. To ease exposition, the literature review will be organized from downstream (outcome) to upstream (predictor) variables. Figure 1 presents the conceptual model; the full explanation is outlined later.

A variety of psychosocial variables might be expected to predict somatization. Operant conditioning approaches emphasize the importance of contingent reinforcement in the development of styles of pain behavior and somatization (Fordyce, 1976). Dunn-Geier, McGrath, Rourke, Latter, and D’Astous (1986) found that the mothers of adolescents who were missing school because of pain were more likely to encourage avoidance of distress and discourage coping than mothers of matched controls, supporting the existence of familially mediated reinforcement of somatization. A direct relationship also has been found between parents’ encouragement of illness behavior (a concept that resembles somatization closely) and their children’s somatization (Walker & Zeman, 1992). These findings support the expectation that children whose parents report encouraging illness behavior should exhibit increased somatic complaints.

Modeling theory (Craig, 1986) suggests that pain behavior and somatization are influenced by relevant behaviors displayed by family members. Several findings are consistent with this expectation (Campo & Fritsch, 1994; Garralda, 1996). For example, a higher incidence of abdominal pain disorders has been reported in the families of children with recurrent abdominal pain than of healthy children (Apley, 1975), and the number of pain models in one’s home has been found to be positively related to the frequency of pain reports (Edwards, Zeichner, Kuczmierniczky, & Boczkowski, 1985). Other studies suggest that the relationship between modeling and somatization in children may not be straightforward. For example, Walker, Garber, and Greene (1991) found that the somatization scores of children with recurrent abdominal pain of uncertain origin were positively related to somatization scores of their parents. However, the somatization scores of parents and children were unrelated among patients with pain associated with demonstrable pathology and a healthy control group. In a longitudinal study, Walker, Garber,
and Greene (1994) found that parental somatization was associated prospectively with somatic complaints in their children. Paternal somatization varied directly with child somatization, whereas maternal somatization was associated only with child somatization among boys from families with high levels of stressful life events. These findings provide some support for a social learning perspective; however, they suggest that complex social processes may differ across patient groups.

Although pain is not the same thing as somatization, a repertoire of somatic complaints may be built on a substrate of individual differences in pain reactivity. For example, children who react more vigorously than others to painful stimulation may react more vigorously to other forms of discomfort and provide greater opportunity for reinforcement of general bodily complaints. Alternatively, enhanced pain reactivity and somatization may both reflect the operation of a third variable, such as enhanced sensitivity to somatic sensations. For these reasons, pain reactivity can predict somatization.

Pain expression occurs in a social context and can be understood as serving a communicative function (Prkachin, 1986). During inoculations, parents respond to their children’s behavior with behavior changes of their own (Negayama, 1999). Behaviors such as reassurance, empathy, criticizing, and bargaining with the child have been related to increased child distress, whereas distraction and nonprocedural talk have been related to decreased levels of distress (Blount et al., 1989; Cohen, Manimala, & Blount, 2000; Dahlquist, Power, & Carlson, 1995; Frank, Blount, Smith, Manimala, & Martin, 1995; Gonzalez, Routh, & Armstrong, 1993; Sweet & McGrath, 1998). Presumably parents’ behaviors represent attempts to influence their children (Kopp, 1982). Although it has been suggested that some parental behaviors may increase children’s distress, parents may be reacting to early cues of their child’s distress. For example, Dahlquist et al. (1995) found that parents’ rate of verbal interaction predicted child distress. The authors suggested that parents may be sensitive to signs of distress in the child and therefore more likely to interact with the child to modulate their distress. Accordingly, in this study, maternal behavior was modeled as a downstream variable reflecting the expectation that higher levels of behavioral response to the vaccination among children would be associated with increased maternal responses. We examined maternal behaviors previously identified in the literature, including the provision of emotional support, distraction, praise, explanation, bargaining, threatening, criticizing, pleading, expressing pain, and anxious verbalizations.

Pain reactivity is probably influenced by several factors. In adults, pain reactivity is associated with social modeling (Prkachin & Craig, 1985). In addition, children bring to the pain experience temperaments that may influence their reactivity. Research has suggested that temperament is associated with pain reactivity. For example, Wallace (1989) reported that hospitalized children rated as high on the temperament variable of intensity were more likely to be administered analgesics postoperatively than children who were rated as less intense. Schechter, Berstein, Beck, Hart, and Scherzer (1991) and Young and Fu (1988) reported that temperament dimensions of approach, nonadaptability, and rhythmicity correlated positively with pain behavior during injections. Grunau, Whitfield, and Petrie (1994) reported that, with the exception of those born at extremely low birthweight, toddlers showing high emotional reactivity were also rated by their parents as highly sensitive to pain. Temperament dimensions reflecting the ease with which a child adjusts to new circumstances (adaptability) and the tendency to approach new situations (approachability) were related to distress during a voiding cystourethrogram (Merrit, Ornstein, & Spicker, 1994). Based on the foregoing, we expected that children described as less adaptable, more likely to withdraw, and more negative in mood would display increased pain reactivity.

Prkachin and Craig (1995) suggested that individuals differ in their sensitivity to evidence of pain in others. Such differences in decoding ability may influence an individual’s response to the pain behavior of others. In this study, we examined whether variations in parents’ ability to decode facial expressions of pain were related to their children’s pain reactivity. Neither current literature nor theory supports a directional hypothesis about the relationship between sensitivity to facial expressions of pain among parents and their children’s pain reactivity; thus, no directional hypothesis was formulated.

There is evidence that previous pain experience influences later pain behavior in complex ways. If attention is restricted to the number of pain experiences, the general results are equivocal. In infants and toddlers, experiencing more medical interventions has been related to decreased sensitivity (Grunau, Whitfield, & Petrie, 1994), but some research has also demonstrated sensitization (Taddio, Katz, Hersich, & Koren, 1997). In older children, some research has suggested habituation to medical procedures (Jacobson, Manne, Gorfinkele, & Schorr, 1990; Jay, Ozolins, Elliott, & Caldwell, 1983), whereas others report no significant effect of previous pain (Katz, Kellerman, & Siegel, 1980; Wong & Baker, 1988). When account is taken of
the intensity or valence of pain experience, the effects appear to be more consistent. Children whose previous pain experiences have been more intense or unpleasant have been reported to exhibit more subsequent distress than children whose experiences have been less intense (Bijttebier & Vertommen, 1998; Dahlquist et al., 1986; Frank et al., 1995). Accordingly, children who had more negative experiences with previous medical procedures likely would display increased pain reactivity.

In summary, theory and existing evidence suggested the formulation of a model in which parental encouragement of illness behavior and the number of pain models in the home are viewed as predictors of somatization. Pain reactivity also is seen as having a central role as a predictor of somatization and parental behavior during inoculation. Pain reactivity, in turn, is viewed as reflecting previous pain experience, temperament, parental decoding ability, and number of pain models. No existing studies have examined these influences comprehensively.

**Method**

**Participants and Setting**

The participants were 163 mothers and their children. The mean age of the children (53% boys) was 62 months ($SD = 3.5$, range = 56–68 months). Eighty-four percent were from two-parent families. Mean maternal age was 32 years ($SD = 5$). Families’ occupational status was generally middle class ($mean \text{ socioeconomic index} = 44.39$, $SD = 13.27$), according to the scale developed by Blishen, Carroll, and Moore (1987). Ninety-four percent of the families were Caucasian; the remainder were Aboriginal and Indo-Canadian. The study was conducted at a community health unit. Seven nurses administered the injections.

Three hundred fifty-nine parents were approached to participate. Two hundred eighty-nine (81%) agreed. Twenty-six parent-child pairs were used as a pilot sample. Due to low participation rates among pilot study fathers, only mothers were recruited for the final study. Four children were not videotaped because they had very strong emotional reactions prior to the needle and were taken to another room. One mother withdrew midway through the procedure. Of the 263 remaining participants, 186 (71%) returned completed questionnaires.

**Apparatus**

An 18-inch color television/VCR combination with remote control was used to show parents video clips. A color video camera mounted on a tripod was used to record the child’s facial behavior. Tapes were later superimposed with a digital time display so that specific time segments could be selected and coded. An 18-inch color monitor and videocassette recorder with remote control, stop action, and slow motion feedback were used to code the videotapes.

**Measures**

**Somatization.** Somatization was assessed by the parent version of the Children’s Somatization Inventory (P-CSI; Garber et al., 1991). The P-CSI is a widely used measure of children’s somatization derived from DSM-IV criteria. Mothers rated the extent to which their children had experienced each of 36 somatic complaints in the last 2 weeks on four-category scales ranging from not at all (0) to a whole lot (3). The total score, obtained by summing the ratings, can range from 0 to 140. The P-CSI has adequate internal consistency ($\alpha = .86$; Garber et al., 1991).

**Encouragement of Illness Behavior.** The extent to which mothers encouraged their children’s reports of somatic complaints was assessed with the Illness Behavior Encouragement Scale (IBES; Walker & Zeman, 1992). This measure consisted of 10 items referring to parent responses to pain symptoms. Adequate internal consistency ($\alpha = .83$), test-retest reliability, and construct validity have been demonstrated for the IBES (Walker & Zeman, 1992). Items 3 and 6 of the original scale were removed as they pertained to homework and were not appropriate for this age group.

**Number of Pain Models.** Mothers completed a form on which they reported the number of people in the home, either presently or in the past, who had experienced chronic pain. The total number of people reported was used as the number of pain models in the home.

**Child’s Pain Reactivity.** Facial responses during inoculation were used to index the child’s pain reactivity, using an abbreviation of the Facial Action Coding System (FACS; Ekman & Friesen, 1978). One trained coder carried out all the coding, and a second scored 7% of the segments ($n = 12$) to determine interobserver agreement. Both coders had demonstrated proficiency on the FACS final test (Ekman & Friesen, 1978).

The facial action units (AUs) coded were AU 4 = brow lowerer, AU 6 = cheek raise, AU 7 = lid tightener, AU 9 = nose wrinkle, AU 10 = upper lip raise, AU 20 = lip stretch, AU 27 = jaw drop, and AU 43 = eyes closed. These actions have been identified by a number of researchers as being correlated with pain (e.g., Craig, Hyde, & Patrick, 1991; Prkachin, 1992; Prkachin & Mercer, 1989). An intensity score, ranging from 1 (barely evident) to 5 (maximal), was assigned to each of the actions present. Interobserver agreement, calculated according to the formula...
given by Ekman and Friesen (1978), was .87, which compares favorably with other FACS studies.

A FACS pain index was calculated by summing the products of the intensity (1–5) of each AU and its duration (Prkachin, Berzins, & Mercer, 1994). The following 10-second segments were coded: (a) baseline: 10 seconds prior to the injection, (b) reaction to the injection, and (c) recovery: 10 seconds after the injection. Actions were coded as present if the onset occurred during the designated time or if the onset was prior to the designated time, but evidenced an increase of two or more intensity points. For procedural reasons, in 4% of the segments, the child’s face was not visible.

Maternal Responses. A measure of the mother’s behavioral responses to her child’s inoculation was developed and applied to videotapes of the parent-child interaction. Ten categories of behavior were derived from the literature (e.g., Blount et al., 1989; Jacobsen et al., 1990; Patterson & Ware, 1988) and operationalized: emotional support, distraction, praise or positive talk, explanation or procedural statements, bargain/reward, yell/threaten, criticize, anesthesia, and “severe pain.” VAS scores for each excerpt were correlated with FACS scores quantifying the intensity of the patients’ pain. The resulting correlation coefficient calculated for each mother was taken as a measure of her ability to decode pain. The mean correlation between maternal ratings and patient pain scores was .52 (SD = .15).

Child’s Previous Pain. Mothers completed a form that asked questions about their child’s previous experience with medical procedures. They rated their child’s reaction to the following experiences: medical and dental appointments, throat cultures, blood work, hospitalizations, and surgeries. A 7-point Likert scale (negative, neutral, positive) taken from Dalhquist et al. (1986) was used for the ratings. An index of the amount of previous negative experience with medical procedures was calculated by summing the number of medical procedures to which the child had shown a negative response (i.e., a rating of 1, 2, or 3). The mean negative experience score was 1.6 (SD = 1.4).

Procedures
Assessment of mothers’ abilities to decode pain behavior took place in a private room. On completion of this assessment, they were given a package containing the questionnaires and demographics. Mothers were provided with a self-addressed, stamped envelope and asked to complete the forms at home and return them.

All children were administered a single 5 cc DPTP inoculation in the upper arm. The immunizations were carried out in a large cubicle that had a video camera. Children were seated on their mothers’ laps, while the nurse swabbed the skin with alcohol and then administered the injection.

Results
Data Preparation
To simplify the temperament data, BSQ variables were subjected to a factor analysis employing a principal components extraction with varimax rotation. The three factors extracted accounted for 64% of the shared variance. Loadings are shown in Table 1. Variables are ordered and grouped by size of loading to facilitate interpretation. Items with loadings of .5 or greater on the factors were used to aid in interpretation of the constructs. Activity and persistence loaded on Factor 1, which was labeled accordingly. Approach/withdrawal, mood, and adaptability loaded on the second factor, called Adjustment. Intensity, distractibility, and sensory threshold loaded on Factor 3 and this construct was called Sensitivity. These findings are consistent with a factor analysis performed on the BSQ in nursery school children by Simonds and Simonds (1982).
Table II presents data on the occurrence of the maternal responses to inoculation. Due to the low occurrence of several categories, only behaviors displayed by at least 10% of mothers were used for analysis. Four behaviors met this criterion: emotional support, explaining/procedural statements, praise or positive talk, and distraction. The frequencies of these behaviors were summed to yield a single score (0–4) reflecting the number of types of maternal responses during inoculation. Mean number of maternal responses was 1.8 (SD = .92).

Of the 186 participants who returned their questionnaires, 21 were excluded due to missing data. Two cases were identified as multivariate outliers and were deleted according to the recommendations of Tabachnick and Fidell (1996). Thus, 163 cases remained for analysis.

Analyses

Table III presents bivariate correlations among all the variables. Several low-to-moderate but nevertheless significant relationships (all ps < .05) were observed. In particular, the temperament variable of adjustment showed significant associations with previous pain, pain reactivity, and somatization. Previous pain experience was associated with illness behavior encouragement, somatization, maternal behavior, and particularly pain reactivity. Pain reactivity, in turn, was significantly related to maternal behavior and somatization.

The conceptual model of Figure 1 was used to guide a structural modeling analysis, using a maximum likelihood method, in LISREL 8.30 (Joreskog & Sorbom, 1999). Factor scores for the three temperament dimensions were entered in the place of the temperament construct. All exogenous variables were allowed to intercorrelate with one another. The goodness-of-fit results are presented in Table IV. This model provided a reasonable approximation to the empirical data, as indicated by several standard criteria. The $\chi^2$ was not significant, even though the sample was relatively large, and the $\chi^2/df$ ratio was less than 3, which is considered satisfactory by Joreskog (1969). Furthermore, the Root Mean Square Residual (RMSR) was low, whereas the Goodness of Fit Index (GFI)
and the Adjusted Goodness of Fit Index (AGFI) were very close to 1. The temperament variable of adjustment (path coefficient = .20) and previous pain experience (path coefficient = .19) emerged as significant predictors of pain reactivity, which, in turn, emerged as a significant predictor of somatization (path coefficient = .22). Pain reactivity was also a significant predictor of maternal response (path coefficient = .33). The coefficients representing the relations between maternal decoding ability, the temperament variables of sensitivity and activity/persistence, and pain reactivity were not significant, nor were the coefficients for the relations between familial modeling and pain reactivity or somatization. Finally, the relation between somatization and illness-behavior encouragement was not significant.

To develop a more parsimonious description of the outcome, we derived a reduced model (see Figure 2) by eliminating the variables that did not contribute significantly in any of the pathways. This model was then reevaluated in LISREL. The reduced model also provided a reasonable fit to the data, with nonsignificant $\chi^2$, low $\chi^2/df$ ratio and RMSR, and high GFI and AGFI. The reduced model did not differ significantly from the original model.

**Discussion**

This study evaluated predictors of somatization and pain reactivity in young children. The results of the structural modeling analyses suggested that the initial conceptual model of predictors of somatization and pain reactivity was a reasonable approximation of the empirical outcome; however, some of the expected relations were not observed and a simplified model also provided a reasonable fit to the data.

**Predictors of Somatization**

Contrary to expectations, somatization as assessed by maternal report on the P-CSI was unrelated either to the presence of pain models or maternal reports of encouraging illness behavior. However, as hypothesized, pain reactivity was a significant predictor of somatization. This finding is new to the literature. The fact that the measures of pain reactivity and somatization were derived from different sources (one from observations of behavior and the other from mothers) and assessed at different times enhances our confidence that this is a meaningful finding. Although the P-CSI contains items that assess pain responses, it also assesses a more generic range of illness presentation consistent with the concept of somatization (i.e., a tendency to present a variety of somatic complaints). Because pain is the cardinal somatic complaint, it seems reasonable to suggest that the child's response to an acute pain stimulus may be a marker of how that child responds to physical symptoms in general. This observation has two potentially important implications. First, observations of

---

**Table IV. Goodness-of-Fit Indices for Both Models Evaluated in the Study ($N = 163$)**

<table>
<thead>
<tr>
<th></th>
<th>Full Model</th>
<th>Reduced Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\chi^2$</td>
<td>19.16</td>
<td>8.04</td>
</tr>
<tr>
<td>df</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>$p$</td>
<td>.16</td>
<td>.15</td>
</tr>
<tr>
<td>$\chi^2/df$ ratio</td>
<td>1.37</td>
<td>1.61</td>
</tr>
<tr>
<td>GFI</td>
<td>.98</td>
<td>.98</td>
</tr>
<tr>
<td>AGFI</td>
<td>.91</td>
<td>.94</td>
</tr>
<tr>
<td>RMSR</td>
<td>.049</td>
<td>.062</td>
</tr>
</tbody>
</table>

Full Model is the model of Figure 1. Reduced Model is the model of Figure 2, in which variables that were not significant in the initial analyses were eliminated.
children's pain reactivity may provide a means of identifying those at risk of future somatization disorders or increased engagement with health care. Second, increased study of parents' and others' responses to pain expression may help identify mechanisms responsible for the development or prevention of somatization.

The foregoing conclusions assume a degree of continuity between somatization, as assessed by the P-CSI, and the clinical entity of somatization. Few, if any, of the children who participated in this study would meet diagnostic criteria for somatization. There is debate over criteria for identifying clinically significant somatization with the P-CSI (Campo & Fritsch, 1994; Garralda, 1996). If a stringent criterion of 13 or more symptoms is applied, then only 3.6% of our sample would qualify. This figure is slightly higher than the 1.1% reported by Garber et al. (1991), and the mean P-CSI score in this sample (3.48) was slightly higher than that of slightly older children (2.14) in Garber et al. (1991). In a longitudinal study of predictors of somatization among children 4.5 years of age, from data at 3 years, Grunau, Whitfield, Petrie, and Fryer (1994), using a different instrument, reported that none of their sample of otherwise healthy 4.5-year-olds exceeded clinical cutoff scores for somatization. In the same sample, followed up at ages 8–10, 8% exceeded clinical cutoffs (Grunau, Whitfield, & Petrie, 1998). Thus, although caution is warranted in interpreting the meaning of the term somatization in this study, the characteristics of our sample do not differ markedly from others in the literature.

**Predictors of Pain Reactivity**

Children with temperaments characterized as low in adjustment exhibited enhanced pain reactivity. This outcome is consistent with other studies of children from a range of ages (Grunau et al., 1994; Merrit et al., 1994; Schechter et al., 1991; Wallace, 1989; Young & Fu, 1988). Together with this study, these findings suggest that children whom their parents describe as prone to negative mood, unadaptable, and withdrawn also are given to enhanced reactions to pain. The consistency of this finding underscores the importance of considering temperamental differences among children in decisions about their management in medical settings.

Children who had more negative experiences with medical procedures reacted more intensely to the pain of inoculation than those with fewer negative experiences. These findings are consistent with previous literature that takes into account the role of quality of previous medical experience on subsequent pain behavior (Bittjebier & Vertommen, 1998; Dahlquist et al., 1986; Frank et al., 1995). Thus, it seems that quality, rather than number, is the crucial variable mediating the impact of previous experiences with medical procedures. Children may retain vivid memories of negative past experiences that serve to sensitize them and enhance their response to current pains. Indeed, research in adult populations has demonstrated that adult pain and fear levels are associated with recalled experiences of pain from childhood (Pate, Blount, Cohen, & Smith, 1996). Further research into the relationship between memory of painful procedures and subsequent distress in children is warranted.

Mothers' abilities to decode facial expressions of pain were unrelated to their children's pain reactivity. It is possible that the test of decoding ability developed for this study was insufficiently sensitive to reveal relationships with children's pain behavior and that a different form of assessment, perhaps having parents decode the pain behavior of children, would have been more informative. Nevertheless, this study suggests that any relationship between parental decoding of pain expression and pain behavior is not straightforward. Further research is necessary to sort out alternative possibilities and clarify the ecological significance, if any, of individual differences in the ability to decode pain expression.

**Maternal Responses to Children's Pain**

Consistent with previous research with younger children (Sweet & McGrath, 1998), mothers of children who exhibited a stronger response to the inoculation were more likely to interact with their child during the procedure, providing emotional support, praise, distraction, and explanatory and procedural comments during the inoculation. Although these behaviors are quite different from one another and may represent different parental strategies or styles, they are commonly observed in studies of inoculation. Given their knowledge of their child's temperament and previous reactions to pain, mothers may have been able to anticipate their child's level of distress and consequently engage in efforts to quell it. In addition, a mother's behavior may have been governed by her child's response during the inoculation. The correlational analysis supports each of these possibilities, since maternal responses were associated with temperament and previous pain, to a limited degree, and with child reactivity to a greater degree.

**Implications of the Structural Modeling Analyses**

Structural modeling can help evaluate and refine models of complex relationships among variables. Although the initial model that guided this study was statistically consistent with the empirical outcomes, a substantial number
of the expected relationships did not emerge as significant, leading us to propose and test the reduced model of Figure 2. Given the a posteriori nature of the revised model, it can be offered only as a basis for future studies.

The reduced model may not fully capture the dynamic properties of some of the variables it retains. For example, maternal response is conceived within the model as a “downstream” variable. This implies that the behaviors assessed represent the mother’s responses to her child’s pain displays. However, a mother’s behaviors are not simply reactions. They are also attempts to regulate the stressful situation in which she and the child find themselves. This interpretation supports the expectation that, over time, maternal responses to their children should have recursive consequences on the child, possibly affecting pain reactivity or other components of the overall response to inoculation stress. Consistent with this suggestion, Grunau, Whitfield, Petrie, and Fryer (1994) have found that mothers’ sensitivity to cues from their 3-year-old children, assessed by behavioral observation, was associated prospectively with somatization assessed at age 4.5. Such potential effects were not modeled in this study and represent a challenge for future research.

It is important to note some of the limitations of this study. Problems with the measure of family health information may have obscured the hypothesized relationships with pain reactivity and somatization. That is, mothers’ reports of pain problems within the family may have been affected by the unspecific nature of the question (“Does anyone in your home suffer from pain?”). Although previous research has shown that pain behavior and pain models in the home are positively related (Edwards et al., 1985; Jamison & Walker, 1992), it may be more informative to assess whether family members model adaptive or maladaptive pain management strategies.

As fathers were not included in the sample, findings are generalizable only to mother–child influences. Future studies should attempt to obtain data from fathers, as they play an important role in the socialization of pain and somatization for their children (Schechter et al., 1991).

The results support further research into the role of temperament and previous medical experiences in the development of pain and somatization. Understanding how temperament and previous pain experiences can influence coping during painful medical procedures may help to target children at risk for extreme pain reactivity and may ultimately lead to pain interventions tailored to children’s individual predispositions. Further study of the relationship between pain reactivity and somatization is also warranted.

Although the path model employed in this study implies a causal direction from pain reactivity to somatization, obviously such a conclusion is not sustainable solely on the strength of this evidence. However, the methods employed here lend themselves to incorporation into prospective studies that can help resolve causal direction. Because patterns for exhibiting somatization develop in childhood and progress into adulthood, identification of factors that may play a role in the ontogeny of somatization is an important goal for future research. The findings of this study can serve as a foundation for prospective models attempting to account for variation in pain and somatization in young children.

Acknowledgments

We thank Lynn Lee-Ran, Karen Schierer, Christine Gertzen, Caron Hurt, Elizabeth Hughes, Greg Pope, and Reiko Graham for assistance with data collection and reliability coding. We also thank the staff members of the Northern Interior Health Unit and the children and their parents who participated. This study was based on Elizabeth M. Rocha’s master’s thesis submitted to the University of Northern British Columbia. Bruno D. Zumbo is now at the Department of Educational and Counseling Psychology, and Special Education, University of British Columbia.

Received March 12, 2001; revisions received August 15, 2001; accepted March 28, 2002

References


Blount, R. L., Corbin, S., Sturges, J. W., Wolfe, V. V., Prater, J., & James, L. (1989). *The relationship be-


