

# Contributions of Multiple Risk Factors to Child Injury

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**Objective** Most previous research on etiological factors that predict children's unintentional injuries has focused on single independent risk factors that predict injury, but psychological methods and theory lend themselves to simultaneous consideration of multiple risk factors that might together create an increased or decreased risk for injury. **Method** One approach to considering multiple risk factors of child injury, inspired by Lizette Peterson's notion of process analysis, is to consider how risk factors serve in moderated, mediated, and mediated moderation roles to each other. We present two lines of research that exemplify such models. In each, multiple risk factors for child injury are considered within a single theoretical model. **Conclusions** Implications for understanding the etiology of children's unintentional injuries and developing empirically derived injury prevention techniques are discussed.

**Key words** injury; safety; mediation; moderation; mediated moderation.

Most previous research on etiological factors that predict children's unintentional injuries focuses largely on single independent risk factors that predict injury, but psychological methods and theory lend themselves to simultaneous consideration of multiple risk factors that might together create an increased or decreased risk for injury. One approach to considering multiple risk factors of child injury, inspired by Lizette Peterson's notion of *process analysis* (Peterson, Farmer, & Mori, 1987), is to examine how behavioral risk factors for child injury serve in moderated, mediated, and mediated moderation roles to each other. Peterson defined process analysis as an approach that emphasized examination and comprehension of the behavioral process of injury (e.g., Peterson, Brown, Bartelstone, & Kern, 1996; Peterson et al., 1987). Intended to be a tool researchers would use to identify the antecedents and consequences of an injury event, process analysis permits the researcher to consider injury "as a series of person–environment interactions rather than as a discrete event" (Peterson et al., 1987, p. 34), thereby advancing the field beyond consideration of single risk factors for injury toward an understanding of the multiple intricacies of human behavior that together influence risk for injury.

One way to conceptualize the effect of multiple risk factors is through consideration of how various risk factors moderate and mediate each other to affect injury risk. Baron and Kenny (1986) described three models by which predictors of a single outcome might relate to one another: moderation, mediation, and mediated moderation (see also Holmbeck, 1997, 2002). Moderation is present when one variable (the moderator) affects the direction or intensity of the relation between a second (the predictor) and a third (the criterion) variable. Thus, in moderation the predictor and moderator concurrently influence the criterion in a multiplicative manner.

Mediation is present when one variable (the mediator) explains the relation between second (the predictor) and third (the criterion) variables. True mediation occurs when the mediator fully explains the relation between the predictor and the criterion. Partial mediation, which happens more typically, occurs when the predictor affects the criterion both directly and through the influence of the mediator.

Mediated moderation is less familiar to many behavioral scientists. According to Baron and Kenny (1986), mediated moderation emerges when one variable (the mediator) explains both the relation between two

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variables (the predictor and the moderator) and a fourth variable (the criterion) and also explains the relation between the interaction of those two variables (the moderating effect) and the fourth variable (the criterion).

To demonstrate the potential of mediation, moderation, and mediated moderation as tools for considering the theoretical structure of multiple behavioral antecedents of injury risk, we present two models of risk for childhood unintentional injury. The first stems largely from our own research program designed to study the effects of temperament, parenting, and children's estimation of environmental risk on unintentional injury. The second comes from the work of Morrongiello and colleagues and explores the roles of child gender, parenting, and children's attributions to the cause of injury on future injury.

### Example 1: The Roles of Temperament, Estimation of Risk in the Environment, and Parenting

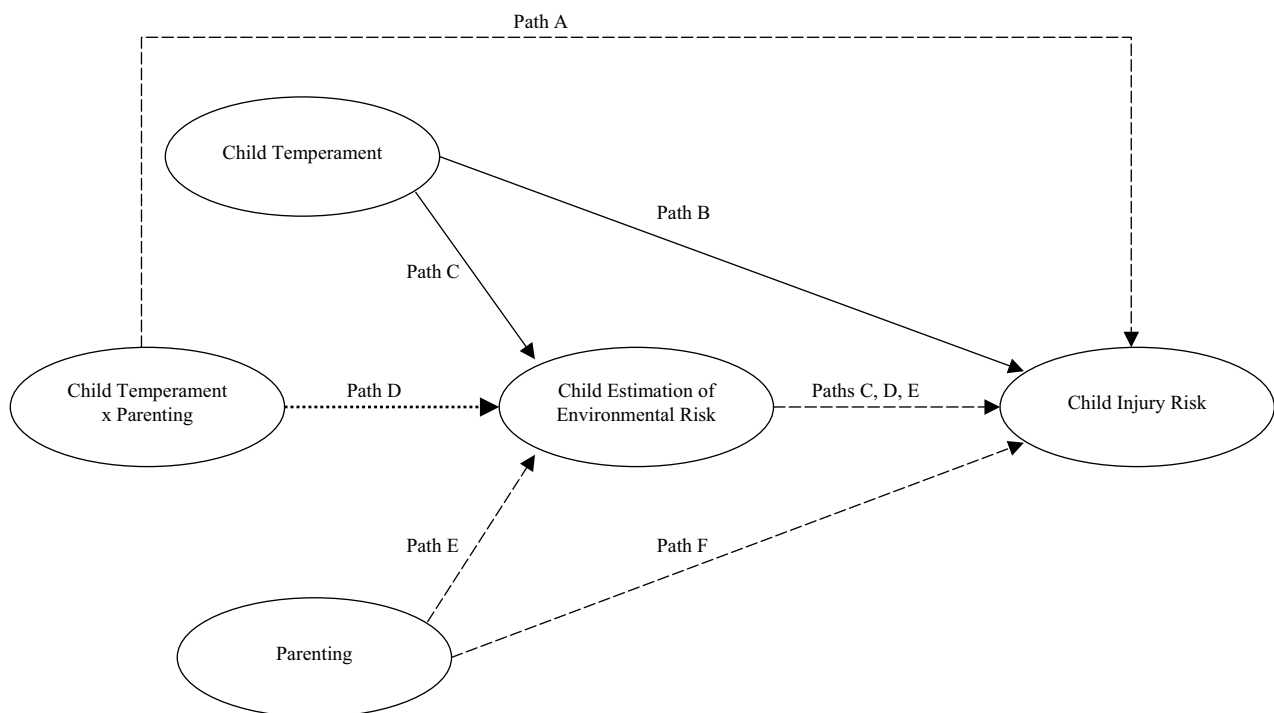
In a series of studies, Schwebel and colleagues (Plumert, 1995; Plumert & Schwebel, 1997; Schwebel & Bounds, 2003; Schwebel, Brezaussek, Ramey, & Ramey, 2004; Schwebel & Plumert, 1999) investigated the combined

role of three risk factors for child injury—temperament, estimation of risk in the environment, and parenting—that appear to relate to children's risk for unintentional injury (See Figure 1).

#### Direct Paths

Children's behavioral style, characterized by developmental psychologists as temperament, has long been associated with children's unintentional injury risk (Path B, Figure 1; Bijur, Golding, Haslum, & Kurzon, 1988; Langley, McGee, Silva, & Williams, 1983; Manheimer & Mellinger, 1967; Matheny, 1986; Pulkkinen, 1995; Schwebel, 2004; Schwebel & Plumert, 1999). The studies were conducted from a range of theoretical approaches and reach a consistent conclusion: aggressive, oppositional, overactive, impulsive, and undercontrolled behavioral styles predict an increased risk of subsequent and concurrent unintentional injury.

Parenting has also been linked to risk for child injury for some time (Path F, Figure 1; Morrongiello & Dawber, 1998; Peterson, Cook, Little, & Schick, 1991; Peterson, Ewigman, & Kivlahan, 1993), although only recently have researchers begun to clarify the mechanisms and efficacy of various parent supervision strategies (Morrongiello, 2005; Morrongiello, Ondejko, &



**Figure 1.** Hypothesized mediated moderation model whereby temperament, parenting, and ability overestimation predicts children's unintentional injury risks. Solid lines suggest evidence for this path exists in two or more peer-reviewed publications, including at least one longitudinal study. Dashed lines suggest replicated correlational evidence for the path exists in two or more peer-reviewed publications. Dotted lines suggest preliminary empirical evidence exists for the path.

Littlejohn, 2004a, 2004b; Schwebel & Bounds, 2003). Initial inquiries into the role of parenting in child injury risk emphasized indirect paths. Single motherhood (Reading, Langford, Haynes, & Lovett, 1999), personality ratings of high neuroticism (Davidson, Hughes, & Richards, 1987) and low conscientiousness (Morrongiello & House, 2004), and maternal mental illness such as depression (Brown & Davidson, 1978) were identified as correlates to increased risk for children's unintentional injury.

More recently, laboratory and naturalistic observation studies have confirmed and extended original epidemiological findings. In particular, researchers have discovered that physical proximity of parents reduces children's risk-taking (Morrongiello & House, 2004; Schwebel & Bounds, 2003). In one study, parents were unobtrusively observed supervising their young children at public playgrounds (Morrongiello & House, 2004). Several measures of the intensity of parental supervision were taken. Among the measures was a rating of parents' physical proximity to the child, which was scored on a 5-point scale every 2 min for a 20-min observational period. Children's risk-taking was also coded for the 20-min observation by summing instances when children used playground equipment in an inappropriate and potentially dangerous manner. Across the sample of 48 parent-child dyads, greater parental proximity to the child was associated with reduced child risk-taking. Similar findings of the importance of quality and quantity of supervision on children's risk-taking behavior have been reported among older children in structured laboratory settings (Schwebel & Bounds, 2003) and in relation to pedestrian safety (Wills, Christoffel et al., 1997; Wills, Tanz et al., 1997).

Children's estimation of risk in the environment is also linked to increased risk for unintentional injury (Hoffrage, Weber, Hertwig, & Chase, 2003; Lee, Young, & McLaughlin, 1984; Morrongiello & Rennie, 1998; Plumert, 1995; Plumert, Kearney, & Cremer, 2004; Plumert & Schwebel, 1997; Schwebel, in press; Schwebel & Bounds, 2003). Plumert and Schwebel's research exemplifies this process. In their paradigm, children judge their ability to complete physical tasks, either tasks such as stepping and reaching (e.g., Plumert, 1995) or tasks involving the crossing of a simulated street (e.g., Plumert et al., 2004). Children who overestimate their ability have a higher rate of unintentional injury than their age-mates (Plumert, 1995; Plumert & Schwebel, 1997; Schwebel, in press).

Others conceptualize estimation of risk in the environment from a slightly different perspective: how do

children judge the risk involved in a particular situation (e.g., Hillier & Morrongiello, 1998; Morrongiello, Midgett, & Stanton, 2000; Morrongiello & Rennie, 1998)? Results parallel those of Schwebel and Plumert (1999). Morrongiello and Rennie (1998), for instance, presented drawings showing models engaged in various dangerous behaviors, asked children to judge the risk involved in the drawings, and found that the judgment of risk in the models was related to participants' self-reported risk-taking.

### **Mediating Paths**

Schwebel and Plumert (1999) have proposed that estimation of environmental risk might mediate the relation between temperamental impulsivity and undercontrol and children's risk for unintentional injury (Path C, Figure 1). One reason impulsive and undercontrolled children might injure themselves with increased frequency, Schwebel and Plumert argued, is because such children judge environmental risk in a rushed, impulsive manner (Plumert & Schwebel, 1997; Schwebel & Plumert, 1999). Such rushed judgment of the environment might lead to misestimation of the risk involved in a particular activity, which in turn could lead to injury (Morrongiello & Rennie, 1998; Plumert, 1995; Schwebel, in press).

Children's judgment of environmental risk might also mediate the relation between parenting and subsequent injury (Path E, Figure 1). Morrongiello and colleagues provide evidence for this relation through a series of studies that found parents encourage risk-taking in their sons more than in their daughters (Morrongiello & Dawber, 1999, 2000), that boys underestimate risk in dangerous situations (Morrongiello & Dawber, 1998; Morrongiello & Rennie, 1998), and that boys have more injuries than girls (Morrongiello, 1997; National Safety Council, 2001).

### **Moderating Path**

A moderating effect between temperament and parenting that relates to children's risk for unintentional injury also has been proposed (Path A, Figure 1; Schwebel et al., 2004). As reviewed above, both the quality and the extent of parental supervision (e.g., Peterson et al., 1993; Morrongiello, 2005; Morrongiello & Dawber, 1998; Peterson et al., 1991) and a child with an impulsive, undercontrolled, and aggressive temperamental style (e.g., Bijur et al., 1988; Matheny, 1986; Schwebel & Plumert, 1999) are linked to an increased risk of child injury. Until recently, researchers had not considered the role careful parental supervision might play in

reducing the risk of temperamentally difficult children. In two large, representative samples, Schwebel and colleagues (2004) found that temperamentally difficult children whose parents spent large quantities of high-quality time with them actually had a *lower* rate of injury than children without difficult temperamental traits. These data provide initial indication of a possible moderating effect between high-quality parental supervision and difficult temperamental styles such that children with difficult temperaments might be protected from injury in the context of quality parenting.

### **Mediated Moderation Path**

Combining the above findings, one might hypothesize a mediated moderation model whereby temperament, parenting, and estimation of risk work together to create an increased or decreased chance of unintentional injury (See Figure 1). The logic is rather straightforward. First, there are direct effects of temperament (Path B) and parenting (Path F) on risk for injury. Second, there are mediating effects of ability overestimation on the relation between temperament and injury risk (Path C) and between parenting and injury risk (Path E). Third, the moderating effect of temperament and parenting affects injury risk (Path A).

The final aspect of mediated moderation is the path whereby the temperament–parenting effect may be mediated in its relation to injury risk by ability overestimation (Path D, Figure 1). In the context of careful supervision, children with difficult temperaments might be more cautious in their estimation of risk in the environment and therefore might be prevented from injury when closely supervised (Schwebel & Bounds, 2003; Schwebel et al., 2004). Schwebel and Bounds (2003) recently reported evidence of this possibility. In a laboratory paradigm, children were asked to judge their physical abilities on tasks such as reaching for a toy off a high shelf and stepping over two parallel sticks. At times, parents were in the room with children; at other times, parents were hidden behind a one-way mirror. Results suggested that children were more cautious in their judgments with parents near them, and this was particularly true for temperamentally impulsive and undercontrolled children (Schwebel & Bounds, 2003). Future research should replicate this finding and in particular should work to understand the processes through which impulsive or undercontrolled children might behave differently in the presence of parents.

### **Summary: Example 1**

The relations between the risk for children's unintentional injury and the risk factors of temperament,

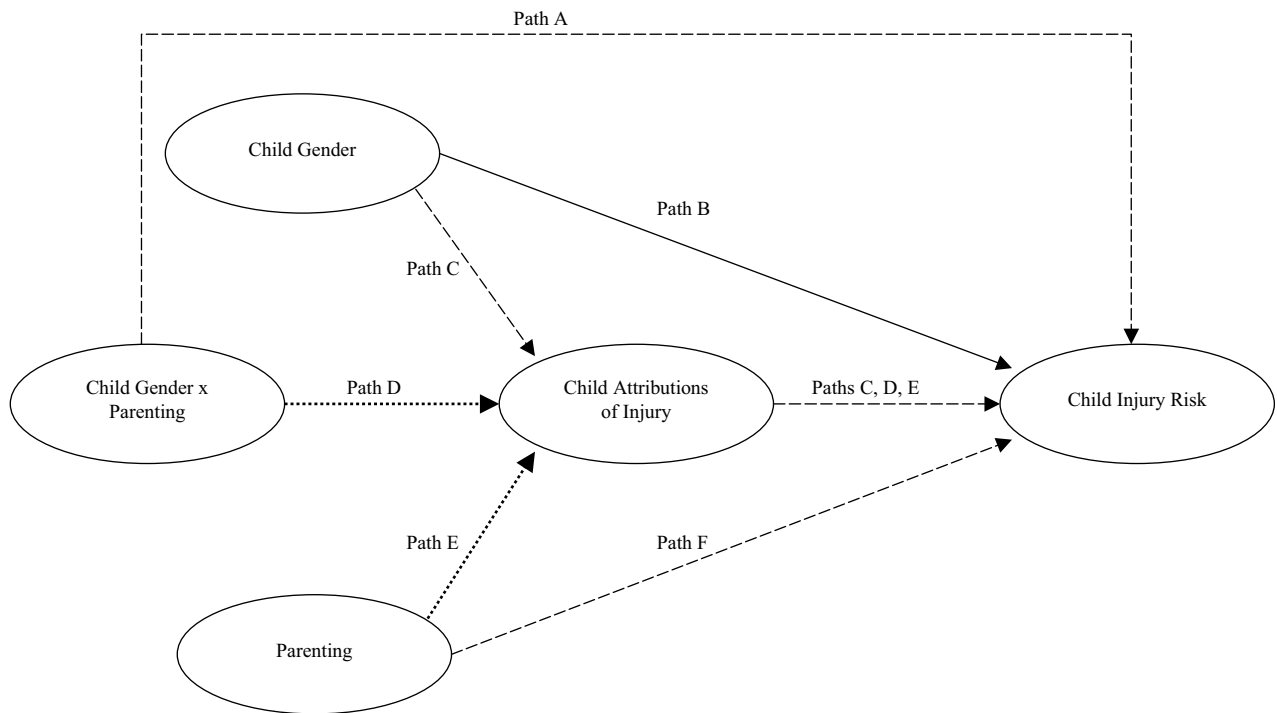
parenting, and estimation of risk in the environment are not simple. Although several researchers report direct links between behavioral traits and children's unintentional injury risk, we hypothesize that the links are more complex than individual and independent direct links. Rather, the variables work together in mediating, moderating, and mediated moderating roles, creating a complex but instructive theoretical model of risk for pediatric unintentional injury.

### **Example 2: The Roles of Gender, Attributions of Injury Risk, and Parenting**

The behavioral antecedents of children's unintentional injuries go far beyond temperament, parenting, and estimation of risk in the environment, of course. As a second example of how risk factors for child injury might fit into a model of mediated moderation, we consider a series of studies by Morrongiello and colleagues examining the roles of gender, children's attributions for injury risk, and parenting behavior (See Figure 2).

Three direct paths are proposed. The first is a link between gender and unintentional injury risk (Path B, Figure 2). Epidemiological data consistently find boys are injured more frequently than girls (National Safety Council, 2001). Theorists posit several explanations for this finding. Biological differences likely play a role, partially through innate gender differences in activity level (Matheny, 1988), impulsivity and inhibitory control (Rothbart & Bates, 1998), and sensation seeking (Zuckerman, 1994). Socialization of gender roles is also cited as an explanation for gender differences in unintentional injury rate (Morrongiello & Dawber, 1998; Morrongiello & Hogg, 2004; Rosen & Peterson, 1990). Boys are expected to take greater risks, to approach physical hazards more quickly and fearlessly, and to consider "accidents" to be bad luck more often than girls; such expectations likely lead to differing injury rates.

The second direct path shown in Figure 2 is that between parenting practices and unintentional injury risk. As reviewed above, several studies evidence this link empirically (Morrongiello, 2005; Morrongiello & Dawber, 1998; Peterson et al., 1991, 1993; Path F, Figure 2). The final direct path is that between children's attributions for injury and actual injury. Children who attribute their injuries to bad luck are presumed to repeat risky behaviors, whereas children who attribute their injuries to dangerous behaviors will alter their behaviors in future risky situations (Gable & Peterson, 1998; Morrongiello, 1997; Morrongiello & Rennie, 1998; Tremblay & Peterson, 1999).



**Figure 2.** Hypothesized mediated moderation model whereby gender, parenting, and attributions of injury predict children's unintentional injury risk. Solid lines suggest evidence for this path exists in two or more peer-reviewed publications, including at least one longitudinal study. Dashed lines suggest replicated correlational evidence for the path exists in two or more peer-reviewed publications. Dotted lines suggest preliminary empirical evidence exists for the path.

Like in Figure 1, Figure 2 also includes two mediating paths. The first suggests attributions of injury might mediate the relation between gender and injury (Path C). Two studies (Morrongiello, 1997; Morrongiello & Rennie, 1998) found boys tend to attribute their injuries to bad luck more often than girls do. In one, 6-, 8-, and 10-year-old children described by telephone the injuries and close-calls (near-injuries) they incurred on a daily basis (Morrongiello, 1997). Boys tended to attribute their injuries to bad luck, whereas girls tended to attribute their injuries to their own behavior. The girls also had fewer repeated injury-risk behaviors, suggesting their attributions led them to change risky behavior patterns more than boys. Morrongiello and Rennie (1998) reported similar results using drawings of injury situations (see Gable & Peterson, 1998, for contrary findings, however). Together, available evidence suggests attribution of injury might mediate the relation between gender and injuries (Path C, Figure 2): boys more frequently attribute their injuries to bad luck, which causes them to experience repeated injuries, whereas girls attribute injuries to their own behaviors, causing them to alter behavior in future situations to avoid injury.

Parenthetically, there is also evidence that *parents'* attributions of injuries might mediate the relation between child gender and children's risk for injury. Morrongiello and Hogg (2004) found that mothers of boys often attribute their sons' injuries to bad luck, whereas mothers of daughters attribute their daughters' injuries to the daughter's behavior. Such attributions likely influence the children's risk for future injury, as evidenced by the data that parents of daughters create rules to avoid recurrence of injuries but parents of boys feel nothing can be done to prevent injury recurrence (Morrongiello & Hogg, 2004; see also Morrongiello & Dayler, 1996).

The other mediating pathway shown in Figure 2 proposes attributions of injury might mediate the relation between parenting and injury (Path E). Direct empirical evidence to support this relation is not yet available, but research in both the parenting and the injury literatures permits speculation. Work in parenting suggests children adopt a wide range of attributions, beliefs, and thoughts from their parents (Sigel, McGillicuddy-DeLisi, & Goodnow, 1992). Although attributions of injury to bad luck or fate wane somewhat over development (Morrongiello & Rennie, 1998),

many adults continue to maintain that a large portion of unintentional injuries are truly “accidental” or due to bad luck (Tremblay & Peterson, 1999). Such beliefs likely affect children’s perceptions regarding injury. Thus, because parental beliefs frequently are passed to children, it seems plausible to hypothesize children’s attributions about injuries might mediate the relation between parenting and injury risk.

The moderating relation illustrated in Figure 2 is a gender by parenting relation that influences injury risk (Path A). Parents socialize, discipline, and react to risk-taking and injury differently for their boys and their girls (Morrongiello & Dawber, 1999, 2000; Morrongiello & Hogg, 2004), and these differences may partially explain varying injury rates among boys and girls. Parents of boys tend to permit and encourage greater independence around potentially dangerous environments (Morrongiello & Dawber, 1999, 2000). They also assume that boys’ behavior is immutable and therefore permit boys to take risks freely (Morrongiello & Hogg, 2004). Parents of girls, in contrast, tend to caution their children about risk, believe they can influence their girls’ behavior to a greater degree, and offer their girls greater physical assistance in potentially dangerous situations (Morrongiello & Dawber, 1999, 2000; Morrongiello & Hogg, 2004). Thus, there is a parenting–gender interaction that appears to influence children’s injury risk. Boys are encouraged to behave independently and recklessly in risky situations, whereas girls are cautioned to engage cautiously and under supervision in risky situations. Boys are socialized to believe injuries are due to bad fortune and repetition of dangerous behavior is acceptable; girls are socialized to believe injuries are due to their own behavior and are taught rules that prevent repeated risky behavior.

The final path shown in Figure 2 is that of mediated moderation: the gender by parenting moderation is proposed to influence injury risk partly through the mediated path of children’s attributions concerning the cause of injury (Path D). Parents typically provide early and consistent instruction to their children on the “appropriate” behavior for their gender (Tenenbaum & Leaper, 2002), including socialization of how to approach and cope with risky environments (Morrongiello & Dawber, 1998; Morrongiello & Hogg, 2004). Such socialization may influence children’s attributions of the risk involved in particular situations (Morrongiello, 1997; Morrongiello & Rennie, 1998; Sigel et al., 1992), which in turn affects injury risk. Future research is needed to verify these hypothesized paths.

## Toward Integrated Models of Multiple Behavioral Risk Factors for Child Unintentional Injury

Inspired by Lizette Peterson’s notion of process analysis as a means to identify behavioral antecedents to injury events (Peterson et al., 1987), we have presented two hypothesized mediated moderation models to explain some of the processes that lead to children’s unintentional injuries.

We present these models partly to stimulate future work on the topics discussed. As illustrated by dashed and dotted lines in the figures, there is evidence supporting many pathways of influence. However, further work is needed to replicate these findings. Two broad questions remain unanswered: applicability of the models to children of varying ages and causality of the paths shown. Most studies reviewed used school-aged children (i.e., ages 6–10) for their analyses. Replication among younger children exists in some cases (e.g., Morrongiello & Dawber, 1998) but is lacking in others. Very little work considers behavioral processes to injury risk during the preadolescent and adolescent years. A similar situation emerges with the causality of the paths shown in the figures. Causality of a few paths is supported through longitudinal findings (e.g., Schwebel et al., 2004; Schwebel & Plumert, 1999), but most remain only correlational links at this time.

A second objective in presenting these hypothesized models is to inspire work in other areas of child unintentional injury research. A wide range of intrapsychic, interpersonal, and environmental factors contribute to children’s unintentional injuries. We have discussed and integrated the contributions of a few; future research should consider others.

## Conclusion

Years ago, Peterson wrote of the importance of identifying and understanding the behavioral etiological factors that lead to child injury, “many scientists now argue that the area [injury prevention] will be best served by a detailed, prospective understanding of the sources of children’s injuries . . . such research will necessitate familiarity with the developmental proclivities of the child, the systems in which the child resides, and behavioral conceptualizations of intervention strategies” (Peterson & Harbeck, 1988, pp. 129–130). The crude but logical rebuttal to that statement, still true today, was: “So what?” Identification of risk factors for injury is

interesting, but prevention is most relevant to children and their families.

We agree that both behavioral and environmental efforts for injury prevention must continue, but only simultaneously with continued efforts to develop etiological models that explain the multiple risk factors for children's injuries. Over a decade ago, a two-part special issue of *Journal of Pediatric Psychology* was devoted to theory-driven research in pediatric psychology (Wallander, 1992a). In the introduction to those issues, editor Jan Wallander discussed the poor representation of theory-driven research in pediatric psychology and the value of articles that include a theoretical approach to pediatric psychology research (Wallander, 1992b). Theory, he wrote, "explains, as opposed to describes, phenomena [and can] lead to a set of hypotheses clearly identifying the relationships which are to be studied and what the expected outcome will be" (Wallander, 1992b, p. 522). By explaining the set of phenomena that place children at risk of unintentional injury, we might better understand the process by which we could prevent those injuries from occurring. Lizette Peterson paved the way for theory-based psychological research on the etiology of child injury; as her successors, we must now continue along the trail she blazed.

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