Journal of Pediatric Psychology, Vol. 23, No. 1, 1998, pp. 33–43

Why Do Boys Engage in More Risk Taking Than Girls? The Role of Attributions, Beliefs, and Risk Appraisals

Barbara A. Morrongiello, PhD, and ***Heather Rennie,*** MSc
University of Guelph

Objective: **Assessed for age and sex differences in school-age children's reporting of injury-risk behaviors, ratings of injury-risk in various play situations, attributions for injuries (self, other, bad luck), and beliefs about their vulnerability to injury in comparison to their peers (more, less, comparable vulnerability).**
Methods: **We used a structured interview and drawings that depicted children showing wary or confident facial expressions when engaged in injury-risk play activities.**
Results: **Children's reported risk taking could be predicted from their risk appraisals, beliefs about the likelihood of injury, and attributions of injuries to bad luck, and these factors resulted in 80% correct assignment of cases by sex in a discriminant analysis. The wary affect display resulted in higher injury-risk ratings than the confident display, with this effect being greater for girls than boys.**
Conclusions: **Cognitive-based factors differentiate boys from girls and contribute to sex differences in children's injury-risk behaviors.**

Key words: *injuries; children; sex differences; beliefs, risk appraisal.*

In the United States, as in most industrialized countries, unintentional injuries rank as the number one cause of death for children beyond one year of age (Baker, O'Neill, & Karpf, 1984; Canadian Institute of Child Health, 1994). For children between 1 and 19 years of age, injuries account for more deaths than all other diseases combined and are a leading cause of visits to emergency departments (Rodriguez, 1990). In fact, recent estimates indicate that one fourth of all U.S. children experience a medically attended injury each year (Scheidt, Harel, Trumble, Jones, Overpeck, & Bijur, 1994). Clearly, injuries pose a significant threat to the health of children.

Injury risk among children, however, varies greatly depending on a number of factors, including age and gender. Injury rates are often reported to increase with age throughout the school years, with adolescents experiencing the highest incidence of injuries (e.g., Scheidt et al., 1994). The type and location of injuries also vary with children's age (Shannon, Bashaw, Lewis, & Feldman, 1992). For example, injuries to infants often occur at home, whereas most injuries to school-age children happen when they are away from home and engage in risk-taking activities. Although boys engage in more risk taking than girls (e.g., Ginsburg & Miller, 1982; Rosen & Peterson, 1990) and have more frequent and severe injuries than girls (Baker et al., 1984; Canadian Institute of Child Health, 1994), we have limited understanding of why this is the case (Morrongiello, 1995).

All correspondence should be sent to Barbara A. Morrongiello, University of Guelph, Psychology Department, Guelph, Ontario, N1G 2W1, Canada. E-mail: bmorrong@uoguelph.ca.

Boys have higher activity levels (Eaton, 1989) and sometimes behave more impulsively (Manheimer & Mellinger, 1967) than girls, which are factors that have been related to injury rates (Matheny, 1988, 1991). In addition, there is speculation in the literature that differential socialization of sons and daughters may play a role in boys being injured more often than girls. For example, parents are less likely to restrain the exploratory behavior of boys than girls, even if the boy's behavior is judged to pose an injury risk (Block, 1983). Similarly, boys are allowed to roam further from home than same-age girls (Saegert & Hart, 1976) and are given more opportunities to play alone (Fagot, 1978), which would result in boys receiving less direct supervision than girls. Thus, a variety of factors have been considered in explaining why boys engage in more risk taking and are injured more often than girls. In the present study we examined the possibility that cognitive-based factors also may contribute to increased injury liability among boys.

The contribution of cognitive-based factors to health-relevant decisions of adults (e.g., seat belt use, smoking, adherence to medical regimens) has been established in the literature (see Janz & Becker, 1984, for review). In the present study we drew on this research in selecting variables that might relate to children's risk taking. Specifically, we assessed children's beliefs about their personal vulnerability for injury and whether they evidenced an optimism bias, that is, a belief that they are less susceptible to injury than their peers. Weinstein (1987) has written extensively on adults' optimism-bias beliefs with respect to health issues, and evidence for this has been found for college students (DeJoy, 1992) and adolescents (Reppucci, Revenson, Aber, & Reppucci, 1991). However, we know of no research demonstrating that similar beliefs are evident and influence health-relevant decisions of elementary-school children.

In the present study, children's attributions for injuries were examined to determine if those who report engaging in risk-taking behavior attribute injuries to bad luck more so than other children who report less risk-taking behavior. We also examined children's appraisal of risk and whether the facial affect displayed by a risk-taking peer model influenced children's risk appraisals. Toward this goal, we presented children drawings of a child engaging in an injury risk play activity, sometimes displaying a confident facial expression and other times expressing a facial display communicating wariness. We reasoned that if children draw on all sources of information available in appraising injury risk, then ratings of injury risk would be lower for those drawings in which the risk-taking model expressed a facial display communicating confidence as opposed to wariness. Although there is considerable evidence that children, from very young ages, draw on the affect displayed by others in understanding and assigning meaning in a given situation (e.g., Dunn & Brown, 1994), it has yet to be determined if such nonverbal communications influence children's judgments about injury-risk. Possibly, children are more likely to underrate the degree of injury risk associated with an activity if a risk-taking peer communicates confidence in what he or she is doing. To date, studies on peer persuasion influences on children's risk taking have focused only on verbal communications (Duryea, Ransom, & English, 1990; Morrongiello & Bradley, 1997; Morrongiello & Christensen, 1997).

Finally, a critical question we sought to address was whether boys and girls differ in their beliefs about injury and appraisal of injury risk, and if these measures could be used to predict risk taking reported by boys and girls. Gender differences in perception of risk associated with alcohol and drug use have been found among college students, with females consistently reporting greater perceived risks than males (Spigner, Hawkins, & Loren, 1993). However, much less is known about gender differences in risk perception at younger ages, and whether such perceptions relate to risk taking per se. One might expect that risk appraisal would be negatively correlated with risk taking, as has been found for adults for financial, criminal, and sports risks (Horvath & Zuckerman, 1993) and with respect to adults' decisions regarding novel activities (Zuckerman, 1979). However, experience with activities can sometimes lead to a reduction in perceived risk (Horvath & Zuckerman, 1993), in which case one might observe no systematic relation between risk appraisal and risk taking for the common play activities examined in the present study.

Method

Subjects

Children 6, 8, and 10 years of age were recruited from 6 schools in 2 school districts in Southwestern Ontario. The schools were selected in a purposeful

way to obtain a broad sampling of socioeconomic groups; type and cost of local housing were used as indicators of socioeconomic status (SES). There were 148 boys and 142 girls in the final sample. Of the boys, 39 were 6- and 7-year-olds (M = 6.6 years, SD = 7 months), 47 were 8- and 9-year-olds (M = 8.4 years, SD = 6 months) and 62 were 10- and 11-year-olds (M = 10.2 years, SD = 5 months). Of the girls, 36 were 6- and 7-year-olds (M = 6.4, SD = 4 months), 45 were 8- and 9-year-olds (M = 8.3 years, SD = 5 months) and 61 were 10- and 11-year-olds (M = 10.1 years, SD = 4 months). All children were fluent in English, in regular classrooms, and had never been hospitalized for an injury.

Materials

Risk-Perception Task Materials

The children were shown black and white line drawings (8 1/2 by 11 inches) depicting a child the same gender as the participant, and roughly the same age; a pilot study involving 50 children confirmed that 6- to 11-year-olds reliably identified the children depicted in the drawings as boys or girls and judged them to be in the 6- to 11-year age group. The drawings, which were individually drawn by an artist, showed the child performing one of 4 activities: cycling, going down a slide at a playground, climbing on monkey bars at a playground, or riding a swing at a playground. We settled on these activities based on a pilot test survey of 50 children 6 to 11 years that revealed that all respondents had experience with these play activities. We then decided on the actual scenes to be drawn based on observations of children at a local playground. We sought to focus on playground activities because many injuries in the target age range happen on playgrounds, with boys experiencing more of these than girls (Coppens & Gentry, 1991; Rosen & Peterson, 1990).

For each activity there were four drawings depicting varying degrees of risk. For example, the child cycling is illustrated a number of ways: (1) both hands on the handle bars, shoes on feet, wearing a helmet (i.e., no risk factors observable); (2) no shoes on, both hands on handle bars and wearing a helmet (i.e., a low level of risk); (3) no shoes on, one hand steering and the other holding a bag, wearing a helmet (i.e., a moderate level of risk); (4) no shoes, one hand steering and the other holding a bag, no helmet (i.e., high risk). The pictures for the other activities were similarly constructed; copies of the individual drawings are available from the author upon request. Pilot testing confirmed that 6- to 11-year-olds consistently rank-ordered the four photos for each activity to match our expected gradations of risk.

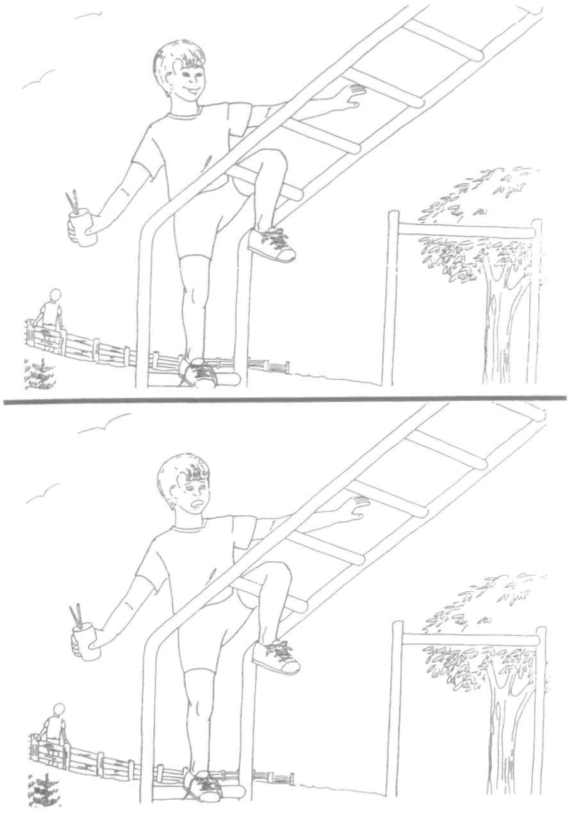

Figure 1. Example drawings showing the confident and wary facial displays. Note that the drawings are identical except for facial affect displayed.

Each drawing was presented twice, once with the child in the drawing smiling and looking confident of his or her performance, another time with the child looking fearful or wary. Extensive pilot testing and revisions to the wary expression were needed to develop an expression that children reliably rated as "fearful" or "afraid," as opposed to sad or angry. The same happy and wary expressions were used for each entire set of drawings. An example contrasting the confident and wary expressions is shown in Figure 1. Thirty-two cards were presented in random order to each child (4 activities × 4 levels of risk × 2 affect displays).

Interview

To assess for differential experiences with the four activities, children were asked how much they en-

gaged in the activity (not at all, not a lot of the time, some of the time, a lot of the time, as much of the time as possible, with these responses receiving scores from 1 to 5, respectively).

For the activities of bicycling, climbing, swinging, and sliding, the children were asked questions to determine: (1) what they believed their likelihood of injury to be relative to that of their friends when engaging in the activity (i.e., likelihood of injury to self > likelihood of injury to peers, self = peers, peers > self); a proportion score based on the four questions (one per activity) was computed to reflect how many responses indicated an optimism bias about the likelihood of injury (i.e., self < peers); (2) how often they experience injuries performing the activity (never, not very often, some of the time, most of the time, nearly all the time, with scores ranging from 0 to 4, respectively), and how severe these injuries usually are (not serious, just a bit serious, pretty serious, very serious, with scores ranging from 0 to 3, respectively); (3) attributions for their injuries when performing the activity, specifically whether they get hurt because of things they do, other people do, or because of bad luck; (4) whether there was a special injury that they thought about when they engage in the particular activity; (5) their skill level in performing the activity (self = peer in how well they perform the activity, self > peer, peer > self).

Injury Behavior Checklist (IBC)

The IBC (Potts, Martinez, & Dedmon, 1995; Speltz, Gonzales, Sulzbacher, & Quan, 1990) consists of 24 items describing activities that could result in injury (i.e., running out into the street, playing with sharp objects, getting into things like paints or cleaners). The children were asked to rate the frequency of a particular behavior on a scale of 0 to 4 (not at all to very often). The frequencies were summed with the highest possible score being 96. We modified the items slightly to make them more appropriate for children through 11 years of age; specifically, we altered the examples provided for each item to make them more age appropriate.

Although the IBC was originally developed for completion by parents, we elected to have the children complete it themselves and we did so for several reasons. First, at these older ages, children are often better informants than parents about injuries they have experienced, with parents often not being told by their older children when minor injuries occur (Morrongiello, 1997; Peterson, Harbeck, & Moreno, 1993). Since parents are not kept informed of injuries and older children are often allowed to play without direct observation by parents, we expected therefore that parents would likely be unaware of risk-taking behaviors in which their older child might engage. Related to this, it has shown that between 6 and 9 years of age children can provide reports of physical risk-taking behavior that are accurate and consistent with parents' reporting on frequency of injury (Potts, Martinez, & Dedmon, 1995). Thus, children at these ages seem aware of their behaviors and quite capable of reporting on these. Second, pilot testing revealed that when parents were unaware of how frequently their older child engaged in a particular activity, they often gave retrospective responses based on what they used to know to be true of their child's behavior. Having children report on their own current behavior avoided this problem. Finally, practically speaking, the large-scale nature of the study precluded our having parents complete the measure.

Procedure

Each child was taken out of his/her class to be interviewed individually by a research assistant. Interviews took place in a quiet area of the school and lasted approximately 35 to 45 minutes. Children completed the risk-perception task first, followed by the interview and then the IBC. The 8- to 10-year-olds completed the IBC by themselves. The interviewer read the questions with the younger children and the children then selected a response.

For the risk-perception task, children were shown one drawing at a time and asked to place each into one of three piles designated as "no risk," "some risk," or "high risk." When the children indicated that there was some risk, they were then asked to sort the card into one of four categories of "some" as depicted by drawings of cups of water with different levels of water. This 2-stage sorting task was developed based on pilot testing, which revealed that younger children sometimes had difficulty with a 6-choice sorting task (e.g., excessively slow to decide, indecisive, not reliable), but these difficulties were not present when the sorting task was divided into two stages.

Generally speaking, extensive pilot testing of all procedures and measures proved invaluable to the development of a procedure that was fun, readily grasped by children 6 through 11 years of age, and limited to 45 minutes maximum.

Results

As in our pilot testing, all children reported experiences with the activities depicted in our stimuli. The average rating for how much they engaged in the activity was 3.8 (3 = some of the time, 4 = a lot), and an analysis of variance (ANOVA) indicated no significant variation in these ratings for any activity due to sex and/or age group (*ps* > .05). Thus, any differences in other aspects of the children's data cannot be attributable to differential experiences with the stimulus activities per se. Similarly, all children reported experiences with injuries while performing these activities: The average rating for incidence of injuries was 1.9 (1 = not very often, 2 = some of the time), with no difference across activities due to age and/or sex (*ps* > .05). These were relatively minor injuries, however, with the average severity rating being 1.2 (1 = not serious, 2 = just a bit serious), with no significant variation in severity ratings due to activity, age, and/or sex (*ps* > .05). Consistent with this, very few children reported any specific "memorable" injury related to these activities (12% of the sample), and none reported any injury requiring hospitalization that resulted from their performing any of the four activities. In sum, this was a sample of children who had experience with the depicted activities and were familiar with minor injuries often associated with performing these activities (e.g., cuts, scrapes, bruises, bumps).

Ratings of Risk

Each of the 32 drawings (4 risk levels × 4 activities × 2 affect displays) was initially assigned a score (1–6) depending on the pile into which it had been sorted (No Risk to High Risk). Subsequently, to obtain an average rating for each level of risk for the confident- and wary-affect drawings separately, the scores assigned each of the four drawings (one per activity) at each level of risk were averaged together, and this was done separately for the confident- and wary-affect drawings. A multivariate analysis of variance (MANOVA) was then applied to the data with Age (3) × Sex (2) × Affect (2) × Level of Risk (4) as factors.

Results revealed a significant three-way interaction of sex × affect × level of risk, $F(3, 371) = 21.26$, $p < .001$, indicating that boys' and girls' risk ratings differed from each other and depended on the level of risk taking and the affect displayed by the child in the drawings; lower-order effects were also significant, indicating that boys gave lower risk ratings than girls, $F(1, 247) = 42.45$, $p < .001$), ratings of risk increased with increasing levels of risk depicted in the drawings, $F(3, 741) = 1874.55$, $p < .001$, children gave lower ratings of risk when the child depicted displayed a confident facial expression as opposed to a wary one, $F(1, 247) = 904.58$, $p < .001$), ratings varied as a joint function of affect × risk-level, $F(3, 741) = 67.00$, $p < .001$, and also as a joint function of sex × risk-level, $F(3, 741) = 21.30$, $p < .001$.

Table I. Average Risk Ratings (Range: 0–6.0) for Boys and Girls for the Positive- and Wary-Affect Conditions as a Function of Degree of Risk Depicted in the Stimulus Drawings (Standard Deviations)

	Risk in stimulus drawings				
Affect	No	Low	Moderate	High	Average
Positive					
Boys	1.0 (.09)	1.6 (.58)	2.4 (.89)	3.6 (.86)	2.1
Girls	1.0 (.15)	1.8 (.59)	3.1 (.69)	4.4 (.89)	2.6
Average	1.0	1.7	2.75	4.0	
Wary					
Boys	1.4 (.45)	2.3 (.79)	3.1 (.49)	5.2 (.67)	3.0
Girls	1.6 (.56)	2.9 (.97)	4.4 (.70)	5.9 (.45)	3.7
Average	1.5	2.6	3.75	5.3	

Table I shows the data relevant to the three-way interaction, namely, boys' and girls' risk ratings as a function of level of risk taking depicted for the confident- and wary- affect drawings. To determine the nature of these differences, four MANOVAs, one per level of risk, were applied to the data, with Sex and Affect as factors.

As can be seen in Table I, for the no-risk conditions, there was a main effect of affect due to lower ratings for the confident, as compared to wary-affect displays, $F(1, 251) = 48.76$, $p < .05$. By contrast, for each of the other three levels of risk, an interaction of gender and affect (*ps* < .05) confirmed differences between boys' and girls' in how much risk ratings increased for the wary-affect display, in comparison to ratings for the confident-affect display. For the low and moderate risk conditions, Newman-Kuels analyses revealed a greater increase in risk ratings for girls than boys for the wary-affect condition relative to ratings for the

Table II. Proportion of Responses Indicating the Likelihood-of-Injury to Oneself Is Less, More, or the Same as That for One's Peers as a Function of Age (years) (Standard Deviations)

	Likelihood of injury to self compared to peers		
Age	Less (optimism)	Same	More
6	.23	.69	.08
	(.21)	(.24)	(.14)
8	.53	.43	.04
	(.33)	(.32)	(.09)
10	.69	.28	.03
	(.26)	(.26)	(.09)

Table III. Proportion of Responses Indicating the Likelihood-of-Injury to Oneself is Less, More, or the Same as That for One's Peers as a Function of Group (Standard Deviations)

	Likelihood of injury to self compared to peers		
Group	Less (optimism)	Same	More
Boys	.57	.38	.05
	(.28)	(.26)	(.11)
Girls	.36	.56	.05
	(.27)	(.29)	(.05)

confident-affect display ($ps < .05$). For the highest risk condition, boys' risk ratings for the confident- and wary-affect displays were significantly less than the corresponding ratings by girls ($ps < .05$), but the magnitude of increase in risk rating for the wary-affect as compared to confident-affect conditions was comparable ($p > .05$), probably because the girls' risk ratings were so high for the confident-affect condition there was limited room for scores to increase under the wary-affect condition.

Beliefs About Vulnerability For Injury (Optimism Bias)

To assess for an optimism bias, the responses to the four questions (one per activity) about likelihood of injury to oneself as compared to peers were averaged to yield a proportion score for each category of response (self = peer, self < peer, self > peer). Since there were few responses indicating personal vulnerability was greater than one's friends' vulnerability, and to avoid the problem of scores summing to 1.0, which limits one's ability to discern group differences, we excluded this response category and applied a MANOVA with Age (3) and Sex (2) and Response Category (2) to the remaining data.

Results revealed an interaction of response category and age, $F(2, 245) = 6.85$, $p < .05$, and Newman-Keuls analyses confirmed systematic changes with age ($ps < .05$). As can be seen in Table II, between 6 and 10 years of age the incidence of optimism-bias responses increased and the incidence of responses reflecting a belief in comparable risk of injury to oneself and one's friends declined.

An interaction of sex and response category, $F(1, 245) = 30.02$, $p < .001$, and a follow-up Newman-Keuls analysis confirmed, as shown in Table III, that boys showed more of an optimism bias than girls, whereas girls rated risk of injury as comparable to peers more so than did boys ($ps < .05$).

Finally, these sex and age differences in optimism bias did not reflect differential beliefs by the children about how well they could perform the activities depicted. An ANOVA on their performance ratings (self = peer, self better than peer), averaged over activity, revealed only an effect of response category, $F(1, 245) = 1089.3$, $p < .001$: 81% of responses reflected a belief that they could perform the activities as well as their peers, compared to 10% of responses indicating they performed it more poorly than their peers, and 9% of responses indicating that they performed it better than their peers. Thus, age and sex differences in optimism bias cannot be explained by attributing it to a belief by children that they were less prone to injury *because* they were better at the activity than peers.

Attributions for Injuries

Responses to the four questions (one per activity) about attributions for injuries were summed and converted to proportion scores for each category (self, other, bad luck). Since there were few responses indicating attributions to others, and to avoid the problem of scores summing to 1.0, which limits one's ability to discern group differences, we excluded this response category and applied a MANOVA with Age (3), Sex (2) and Response Category (2) to the remaining data.

Results revealed an interaction of attributions with sex, $F(1, 245) = 16.43$, $p < .001$, and also with age, $F(2, 245) = 76.87$, $p < .001$. As can be seen in Table IV, girls attributed more injuries to their own

Table IV. Proportion of Responses Attributing Injuries to One's Own Behavior, the Behavior of Others, and Bad Luck as a Function of Group (Standard Deviations)

	Attributions for injuries		
Group	Self	Others	Bad luck
Boys	.41	.04	.55
	(.32)	(.12)	(.21)
Girls	.57	.04	.39
	(.26)	(.09)	(.20)

Table V. Proportion of Responses Attributing Injuries to One's Own Behavior, the Behavior of Others, and Bad Luck as a Function of Age (Years) (Standard Deviations)

	Attributions for injuries		
Age	Self	Others	Bad luck
6	.20	.05	.79

behavior than did boys, whereas boys attributed more injuries to bad luck than did girls; these findings were confirmed with a Newman-Keuls analysis (*ps* $< .05$). As shown in Table V, with increasing age, the tendency to attribute injuries to bad luck systematically declined, and there was a significant incremental increase in attributions of injuries to one's own behavior, as confirmed by Newman-Keuls analyses (*ps* $< .05$).

Self-Reported Risk Taking (IBC Scores)

A MANOVA was applied to the IBC scores to determine if reported risk taking varied as a function of children's ages and/or sex. Results were consistent with previous findings in the literature: Boys reported more risk taking than girls, $F(1, 247) = 133.34$, $p < .001$). However, as can be seen in Table VI, there were no age differences.

A hierarchical regression was applied to determine if children's reported risk taking could be predicted from attributions to bad luck, level of optimism bias, and risk ratings; preliminary analyses screened for violations of assumptions (cf. Tabachnik & Fidell, 1989) and found none significant. Table VII displays the semipartial correlations, the unstandardized regression coefficients (B), the standardized regression coefficients (β), and R^2 and adjusted R^2 after entry of the independent variables. To control for any effects due to age, in Step 1, this variable was entered first. In Step 2, the remaining variables were entered. As can be seen in Table VII, age alone explained virtually no variance in risk-taking scores ($p > .05$). However, the addition of scores reflecting attributions to luck, optimism bias about the likelihood of injury, and risk-perception judgments significantly increased the explained variance by 53%, resulting in an R of .73, $F(4, 246) = 70.42$, $p < .001$; each of the three variables also independently significantly (*ps* $< .001$) contributed to the regression equation. Children who had higher risk-taking scores made more attributions to luck for their injuries, believed optimistically that they were less likely than peers to be injured, and perceived risk to be lower than children who reported engaging in less risk taking.

To assess for sex differences in the factors that predicted children's risk taking score, the unstan-

Table VI. Average Risk-taking Scores on the IBC (Max = 96) as a Function of Age (Years) and Group (Standard Deviations)

	Age			
Group	6	8	10	Average
Boys	27.8	30.5	28.2	28.8
	(8.1)	(8.2)	(8.4)	
Girls	16.1	18.2	18.4	17.6
	(6.8)	(7.1)	(6.9)	
Average	21.9	24.4	23.3	

Table VII. Results of a Hierarchical Regression Predicting Children's IBC Scores

Step and variables	Partial correlation	B	β
Step 1			
Age	.10	1.1	.10
		$R^2 = .01$	
Step 2			
Att/luck	.50*	16.3	.64
Opt bias	.29*	10.2	.37
Risk app	−.19*	−2.9	−.19
		$R^2 = .53$	
		Adjusted $R^2 = .53$*	
		Multiple $R = .73$*	

B = unstandardized regression coefficient.
β = standardized regression coefficient.
*Designates significance at $p < .05$.
IBC = risk-taking score (dependent variable).
Att/Luck = attributions to bad luck.
Opt Bias = optimism bias.
Risk App = risk appraisal.

dardized coefficients were compared (cf. Cohen & Cohen, 1983). The results indicated that boys and girls did not differ in the factors that best predicted risk-taking scores, that is, risk perception ratings, optimism bias beliefs, and attributions to bad luck.

Finally, we sought to determine the extent to which these variables could be used actually to predict group membership for boys and girls. Toward this aim a standard discriminant analysis was conducted, with four predictors (IBC, attributions to luck, optimism bias, average risk rating) entered simultaneously. Of the cases examined, 80% could be correctly classified into groups based on the four variables considered (78 % of boys and 82% of girls). When separate analyses were run for each age group, similar categorization rates were obtained: 82% for 6-year-olds (77% for boys and 86% for girls), 84% for 8-year-olds (83% for boys and 85% for girls), and 83% for 10-year-olds (81% for boys and 86% for girls). Thus, the classificatory power of the variables was comparable across subgroups within the sample. By chance alone, one would have expected to classify 50% of cases. The model therefore usefully discriminated boys from girls, exceeding chance level by 30%. Furthermore, the discriminant function accounting for 90% of the between-group variance (χ^2 = 128.94, $p < .001$), and the loading matrix of correlations between the predictors and discriminant function (IBC: .88, attributions to bad luck: .37, optimism bias: .40, risk appraisal: -.51) indicated that each of the four variables contributed significantly to distinguishing between the groups ($ps < .05$); loadings less than .3 were not interpretable (cf. Tabachnik & Fidell, 1989).

Discussion

The present study provides a number of insights into factors that predict school-age children's reported risk taking. Attributions of injuries to bad luck, an optimistically-biased belief that one is less vulnerable to injury than one's peers, and judgments downplaying the degree of injury risk all related to self-reported risk taking for boys and girls. However, boys engaged in significantly more risk taking than girls and, consistent with this differential outcome, the pattern of their responses with respect to the three predictive variables differed significantly from those observed for girls. Boys attributed more injuries to bad luck, boys rated risk-of-injury as lower (see also Spigner et al., 1993), and boys expressed more of an optimism bias than girls. In fact, there was sufficient differentiation of boys from girls for risk taking, attributions, optimism bias, and risk ratings that the combined effect of these variables resulted in correct classification of 80% of the children based on their sex in a discriminant analysis.

With respect to risk ratings, boys and girls were both influenced by the affect displayed by the risk-taking model, although boys' ratings of risk were not influenced to the same degree as girls' risk ratings. When the child expressed a wary affect, presumably communicating lack of confidence in his ability to complete the risk-taking activity, the children judged the activity as posing a greater risk of injury to themselves than when the child expressed a facial display communicating confidence in what he was doing. These differences in risk ratings occurred even though the child depicted was engaged in exactly the *same* activity under both facial-affect conditions. Consistent with a number of studies involving adolescents (see Duryea et al., 1990), we previously established that verbal communications in the form of persuasive appeals by children can be very effective to convince other elementary-school children to engage in risk-taking activities that threaten one's safety, even if the children initially rejected these activities because of their risk of injury (Morrongiello & Bradley, 1997; Morrongiello & Christensen, 1997). The present results highlight that nonverbal channels also significantly influence school-age children's risk appraisals. The results suggest that children may engage in an injury-risk activity by virtue of their underrating the degree of risk present based on observing a peer who displays confidence in his or her own ability to perform the risk activity.

With this latter point in mind, it is noteworthy that the risk ratings of boys did not increase as much as those of girls when one compares ratings for the confident and wary conditions. These results suggest that girls assign greater significance to contextually based "evidence" indicating injury-risk in a situation (i.e., a peer communicating uncertainty about an activity) than boys. Possibly, since boys are more inclined than girls to adopt beliefs reflecting an optimism bias, they are less inclined than girls to assume that a peer's apparent concern about executing an injury-risk activity has implications for

how successful they themselves would be in so doing. Extending this logic, boys may be more inclined than girls to engage in an injury-risk activity even if they observe a peer get hurt doing the activity. These hypotheses receive some support from a study with 6-, 8-, and 10-year-olds by Hillier and Morrongiello (in press), who found that the best predictor of girls' intentions to take risk was their perceived vulnerability for injury (i.e., beliefs about the likelihood of getting hurt), whereas for boys it was perceived severity of injury (i.e., beliefs about how hurt they might get).

One noteworthy result in the present study was that there was no variation in risk-of-injury ratings across age. Although responses indicating an optimism bias increased with age, reflecting a growing belief by children that they are less vulnerable to injury than others, this apparently did not distort children's appraisals of risk. Children obviously recognized variation in injury risk across the situations presented them. Similarly, although younger children were especially inclined towards attributing injuries to bad luck, they nonetheless recognized the degree of injury risk present and judged risk comparably to older children. Apparently, children between 6 and 10 years assigned similar significance to observing the risk factors presented in the stimuli used herein (e.g., bicycling without a helmet or shoes). Recently, Peterson, Oliver, Brazeal, and Bull (1995) reported age-related decreases in children's ratings of anticipated severity of bicycle injuries, although this trend paralleled age-related increases in injury-risk ratings. The results of our research suggest that decreases in judged injury severity with age may be another variant on the type of optimism bias we observed herein with respect to children's beliefs about the likelihood of injury, as opposed to reflecting changes in risk perception with age.

Although the present research expands our understanding of factors that contribute to increased injury liability among boys, there are some limitations in the study that should be considered in planning future research on this topic. First, there was no independent measure of children's reported risk taking. Our reasons for having children serve as respondents were mentioned previously (see Method), and although we observed the sex differences one would expect based on existing literature, without having data on children's risk taking from another source, we cannot say with certainty that children provided an accurate measure of risk taking in this study. Second, the risk-perception task was a laboratory-based one. Although the stimuli were developed based on naturalistic observation of children's behavior, and the data obtained logically related to the various stimulus conditions, it is still the case that children were provided only static depictions of risk taking and this may have affected their risk judgments in unanticipated and important ways. Finally, the correlational nature of the data precludes drawing firm conclusions about the directionality of the relationships observed. Specifically, although we suggest that high-risk takers expect lower injury, have an optimistic bias about injury, and believe that injury results from bad luck, these results are also consistent with Horvath and Zuckerman's (1993) suggestion that judgments and perceptions about risk result from risk taking, as opposed to determining risk taking. Future research needs to more closely examine the determinants, as opposed to correlates, of children's risk taking.

In conclusion, the present findings highlight the potential role of cognitive-based factors for understanding children's risk taking and reveal the influence on risk appraisal of nonverbal communications by peers modeling risk-taking behaviors. The results reveal a key challenge facing interventions aimed at reducing risk taking among school-age children, namely, risk-taking decisions are multidetermined, being influenced by a number of contextual (e.g., affect displayed by peer modeling risk taking) as well as individual-based (e.g., beliefs about vulnerability, attributions) factors. Future research should seek to determine the basis for sex differences in children's attributions, optimism bias, and risk appraisals.

Acknowledgments

This research was supported by grants from the Hospital for Sick Children Foundation and the Social Sciences and Humanities Research Council. We thank the schools for welcoming us, the children for their interest and participation, and Lorna McCleary and John Flanders for assistance with data collection, Tess Dawber for assistance with data analysis, and Kevin Kelloway for statistical advice and consultation.

Received August 21, 1996; accepted July 9, 1997 (by Annette M. La Greca, previous Editor)

References

Baker, S., O' Neill, B., & Karpf, R. (1984). *The injury fact book*. Lexington, MA: Lexington Books.

Block, J. (1983). Differential premises arising from differential socialization of the sexes: Some conjectures. *Child Development, 54,* 1335–1354.

Canadian Institute of Child Health. (1994). *The health of Canada's children,* 2nd ed.. Ottawa: Canadian Institute of Child Health.

Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: LawrenceErlbaum.

Coppens, N., & Gentry, L. (1991). Video analysis of playground injury risk situations. *Research in Nursing & Health, 14,* 128–136.

DeJoy, D. (1992). An examination of gender differences in traffic accident risk perception. *Accident Analysis and Prevention, 24,* 237–246.

Dunn, J., & Brown, J. (1994). Affect expression in the family, children's understanding of emotions, and their interactions with others. *Merrill Palmer Quarterly, 40,* 120–127.

Duryea, E., Ransom, M., & English, G. (1990). Psychological immunization: Theory, research and current health behavior applications. *Health Education Quarterly, 17,* 169–178.

Eaton, W. (1989). Are sex differences in child motor activity level a function of sex differences in maturational status? *Child Development, 60,* 1005–1011.

Fagot, B. (1978) The influence of sex of child on parential reactions to toddler children. *Child Development, 49,* 459–465.

Ginsberg, H., & Miller, S. (1982). Sex differences in children's risk taking behavior. *Child Development, 53,* 426–428.

Hillier, L., & Morrongiello, B. A. (in press). Age and gender differences in school-age children's appraisals of injury risk. *Journal of Pediatric Psychology.*

Horvath, P., & Zuckerman, M. (1993). Sensation seeking and risk appraisal and risky behavior. *Personality & Individual Differences, 14,* 41–52.

Janz, N., & Becker, M. (1984). The health belief model: A decade later. *Health Education Quarterly, 11,* 1–47.

Manheimer, D., & Mellinger, G. (1967). Personality characteristics of the child accident repeater. *Child Development, 9,* 87–101.

Matheny, A. (1988). Accidental injuries. In D. Routh (Ed.), *Handbook of pediatric psychology* (pp. 103–134). New York: Guilford.

Matheny, A. (1991). Children's unintentional injuries and gender: Differentiation by environmental and psychosocial aspects. *Children's Environments Quarterly, 8,* 51–61.

Morrongiello, B. A. (1995) Unintentional injuries to children: Why do boys have more injuries than girls? *Canadian Health Psychologist, 3,* 21–24.

Morrongiello, B. A. (1997). Children's perspectives on injury and close-call experiences: Sex differences in injury-outcome processes. *Journal of Pediatric Psychology, 22,* 499–512.

Morrongiello, B. A., & Bradley, M. (1997). Sibling power: The influence of older siblings' persuasive appeals on younger siblings' judgements about risk taking behaviors. *Injury Prevention, 3,* 23–28.

Morrongiello, B. A., & Christensen, S. (1997). The influence of peers on children's judgements about engaging in behavior that threatens their safety. *Journal of Applied Developmental Psychology, 18,* 547–562.

Peterson, L., Harbeck, C., & Moreno, A. (1993). Measures of children's injuries: Self reported versus maternal reported events with temporally proximal versus delayed reporting. *Journal of Pediatric Psychology, 18,* 133–147.

Peterson, L., Oliver, K., Brazeal,T., & Bull, C. (1995) A developmental exploration of expectations for and beliefs about preventing bicycle collision injuries. *Journal of Pediatric Psychology, 20,* 13–22.

Potts, R., Martinez, I., & Dedmon, A. (1995). Childhood risk taking and injury: Self report and informant measures. *Journal of Pediatric Psychology, 20,* 5–12.

Reppucci, J., Revenson, T., Aber, M., & Reppucci, N. (1991). Unrealistic optimism among adolescent smokers and nonsmokers. *Journal of Primary Prevention, 11,* 227-236.

Rodriguez, J. (1990). Childhood injuries in the United States. *American Journal of Diseases of Children, 144,* 625-626.

Rosen, B., & Peterson, L. (1990). Gender differences in children's outdoor play injuries: A review and integration. *Clinical Psychology Review, 10,* 275–294.

Saegert, S., & Hart, R. (1976). The development of environmental confidence in boys and girls. In P. Burnett (Ed.), *Women in society* (pp. 157–175). Chicago: Maaroufa Press.

Scheidt, P., Harel, Y., Trumble, A., Jones, D., Overpeck, M., & Bijur, P. (1994). The epidemiology of nonfatal injuries among US children and youth. *American Journal of Public Health, 85,* 932–938.

Shannon, A., Bashaw, B., Lewis, J., & Feldman, W. (1992). Nonfatal childhood injuries: A survey at the Children's Hospital of Eastern Ontario. *Canadian Medical Association Journal, 146,* 361–365.

Speltz, M., Gonzalez, N., & Sulzbacher, S., & Quan, L. (1990). Assessment of injury risk in young children: A preliminary study of the Injury Behavior Checklist. *Journal of Pediatric Psychology, 15,* 373–383.

Spigner, C., Hawkins, W., & Loren, W. (1993). Gender dif-

ferences in perception of risk associated with alcohol and drug use among college students. *Women & Health, 20,* 87–97.

Tabachnik, B., & Fidell, L. (1989). *Using multivariate statistics*. New York: Harper Collins.

Weinstein, N. (1987). Unrealistic optimism about susceptibility to health problems. *Journal of Behavioral Medicine, 10,* 481–500.

Zuckerman, M. (1979). Sensation seeking and risk taking. In C. Izard (Ed.), *Emotions in personality and psychopathology* (pp. 163–197). New York: Plenum.