Journal of Behavioral Decision Making
J. Behav. Dec. Making, **16**: 397–413 (2003)
Published online 15 October 2003 in Wiley InterScience
(www.interscience.wiley.com) **DOI**: 10.1002/bdm.453

Risk Preferences in Young Children: Early Evidence of Individual Differences in Reaction to Potential Gains and Losses

IRWIN P. LEVIN* and STEPHANIE S. HART
The University of Iowa, USA

ABSTRACT

New methods were developed for studying risky decision making in children as young as age five. Each child was given a block of 'gain' trials, for example, a choice between a sure gain of one prize and a 50:50 chance of gaining either two prizes or no prize, and a block of 'loss' trials, for example, a choice between a sure loss of one prize and a 50:50 chance of losing either two prizes or no prize. We were thus able to compare risky choice for gains and losses at the level of the individual child. In each of two experiments a variety of individual difference variables were measured, including in Experiment 2, the child's parent's scores on the same task. Across experiments, the preponderance of choices was of the risky option. However, most children and adults made more risky choices in the domain of losses than in the domain of gains. Predictors of individual differences in children included shyness, impulsivity, and the risk taking of the child's parent. We suggest that methods are now in place to encourage further studies of decision processes in young children. Copyright © 2003 John Wiley & Sons, Ltd.

KEY WORDS children's decision making; risky choice; individual differences

The vast majority of research in decision making has been conducted with adults rather than children. Controlled studies leading to the development of descriptive models of decision making are plentiful with adults because of their ability to understand instructions and tasks, as well as the underlying concepts such as risk and probability. Adults can also readily express their choices and perhaps even the reasons behind them. Nevertheless, large individual differences have been observed in response to decision tasks beyond the overall effects observed with aggregate data. A question addressed by the present research with children is whether the sources of such individual differences can be uncovered at an early age.

Recent research has revealed that significant variance in observed decision biases can be accounted for by measures of cognitive ability, personality, and rationality (Lauriola & Levin, 2001; Levin et al., 2002; Stanovich, 1999; Stanovich & West, 1998). For example, a key question is which of the deviations from

*Correspondence to: Irwin P. Levin, Department of Psychology, The University of Iowa, 11 Seashore Hall E, Iowa City, IA 52242-1407, USA. E-mail: irwin-levin@uiowa.edu

Contract/grant sponsor: National Science Foundation, USA; contract/grant numbers: SES 00-01316; SES 02-17620.
Contract/grant sponsor: Spelman-Rockefeller Program, USA.

normative theory can be attributed to cognitive or computational limitations. A parallel question is how such deviations relate to individual differences in personality and temperament that serve as moderators of affective reactions to different choice situations. A contention of the present investigation is that studies with children, whose cognitive and emotional development are still in progress and thus highly variable, offer great promise for better understanding of the bases for various decision biases. In this study we focus on preference shifts in risky choice: the tendency to make more risky choices to avoid losses than to achieve gains of the same magnitude.

We address the dual questions of whether the effects observed with adults can also be detected in young children, and whether links between trait variables and risky choice exist at early stages of development. Consider the simplest case of risky choice where the choice is between a riskless option whose outcome is known with certainty and a risky option of equal expected value whose outcome is uncertain. This paradigm has been popular because of both its theoretical and practical implications. Risky choice has been studied as a way of testing normative models of decision making (Subjective Expected Utility Theory) in which it is optimal to choose that option with the highest subjective expected utility. There is some evidence that the discrepancy between normative prediction and actual behavior narrows with age, but this has primarily been tested with adolescents, not younger children (Klaczynski, 2001). Risky choice has also been linked to everyday behaviors such as healthy or unhealthy life styles, gambling, and thrill-seeking (Dahlback, 1990; Vollrath, Knoch, & Cassano, 1999). It is the researcher's challenge to devise methods for studying risky decision making in young children and, in the case of the present goals, to determine the antecedents to the development of individual differences in risk attitudes and preferences.

We are aided in this endeavor by the work of a relatively small number of researchers who have investigated judgment and decision making in young children. These researchers have shown that children as early as age five or six can do the following: (1) understand the concept that one thing can be more probable than another (Huber & Huber, 1987); (2) understand the concept of risk (Harbaugh et al., 2000); and (3) integrate two or more dimensions of information to arrive at a unified judgment (Schlottmann & Anderson, 1994; Schlottmann, 2000, 2001), an ability involved in risky choice that relies on both probability and outcome information. A variety of research instruments have been used with children. An example used by several of these researchers is the spinner wheel task. It is explained to the child that different segments of the wheel are associated with different numbers of prizes and that when the wheel is spun, the chance that the marker will end up in a given segment depends on the relative size of that segment (Harbaugh, Krause, & Vesterlund, 2000; Huber & Huber, 1987; Reyna & Ellis, 1994). Other tasks include drawing cards from a deck (Marks, 1951), use of 'safe' vs. 'disaster' switches (Slovic, 1966), simulated traffic-crossing tasks (Ulrich Hoffrage, personal communication, 23 September 2000.) and the use of vignettes representing common decision biases (Baron et al., 1993).

Jacobs and Potenza (1991, see also Jacobs, Greenwald, & Osgood, 1995), Agnoli (1991), and Davidson (1991, 1996) all found evidence of suboptimal decision making in young children when comparing the judgments of children at different grade levels. Jacobs and colleagues found that when making judgments of event likelihood, first-graders were less accurate in estimating base rates and used base-rate information less than third- or sixth-graders. Agnoli found that errors in comparing the relative frequency of a subclass to an inclusive class (e.g. 'On the lake are there more boats or sailing boats?') could be attributed to the use of the representativeness heuristic by children as young as age seven. Davidson used an information-board procedure to show that second-graders were less likely than older children to search for information in a systematic way; older children were more apt to discover simple noncompensatory strategies to narrow their choices that younger children overlooked. Such studies often implicate developmental trends in computational thinking as the reason for their findings but, for present purposes, the important thing is that they demonstrate that specific decision biases known to occur in adults can also be detected in young children. To the best of our knowledge, however, no prior research with children has addressed individual differences traced to the developmental history of these children.

Of particular relevance to the current study is the study by Reyna and Ellis (1994) which was one of the first to examine risky decision making in children as young as those in the present study. As in our study, Reyna and Ellis compared risky decision making in the domains of gains and losses. And as in our Experiment 2, they manipulated the probabilities associated with risky choices. Their study undoubtedly sparked further research in this area, including the present investigation. Nevertheless, there are important differences in research focus and design between their study and ours. While they chose to compare children of different age levels to examine developmental trends, we chose to probe into individual differences within a single age group. Because of our interest in individual differences, we attempted to provide stable data by employing multiple trials for a limited number of task variations. By contrast, Reyna and Ellis provided only one trial at each of 18 combinations of task domain, risk level and outcome magnitude. Their use of a complete factorial design led to some trials with possible outcomes as high as 120. We chose to use values more within the range that young children would easily comprehend. Finally, in our Experiment 2, we use each child's parent as a paired control, a procedure which, to the best of our knowledge, has not been used by any other previous researchers of children's decision making. In addition to these experimental design differences, there are other procedural differences between the Reyna and Ellis study and ours that will be discussed when we consider both the commonalities and differences in results between the two studies.

The design of the present study of individual differences in the risky decision making of young children parallels a recent study of individual differences in adults (Levin et al., 2002). The essential features are: (1) use of a within-subject design where a comparative (difference) score between experimental conditions provides a measure of the experimental effect (i.e. risk taking for losses vs. gains) at the level of the individual decision maker; and (2) use of measures of individual difference, obtained independently from the decision task, which are predictive of task performance.

Additional features were added in each of the two experiments comprising the current study. In each experiment participants actually experienced the consequences of their choices, either winning or losing small prizes (Experiment 1) or dimes (Experiment 2). In Experiment 1 we were able to obtain a relatively small population of children for whom there was a wide array of historical data on personality and temperament. In Experiment 2, which used a larger sample, we gave the parent of each child the exact same task as his or her child, thus enabling us to use the parent's risk taking as a predictor of the child's risk taking.

EXPERIMENT 1

For children aged five to six years old, we chose and pilot tested a task that retained the basic features of the adult risky decision making studies, could readily be understood by the children, and could be adapted to both risk taking for gains and risk taking for losses. Reminiscent of the spinner wheel task but a bit simpler because it required only simple counting skills to ascertain risk level, the task required the child to choose between boxes on one side of a table or the other. In the case of gain trials, boxes on one side contained one prize while boxes on the other side were equally likely to contain two prizes or no prize. For loss trials, boxes on one side contained symbols indicating that one prize would be taken away while boxes on the other side were equally likely to contain a symbol indicating that two prizes would be taken away or a symbol indicating no prize would be taken away. On each type of trial, choice of the side where one prize would certainly be gained or lost represents the 'riskless' choice and choice of the side where the outcome could either be two or zero prizes gained or lost represents the 'risky' choice. If the preference shift typically found in adults (Tversky & Kahneman, 1981) extends to children, then more risky choices will be found on loss trials than on gain trials.

Measures of individual difference in previous studies of risky decision making in adults include personality scales such as those contained in the Big Five Inventory (Digman, 1990) and measures of cognitive ability such as intelligence (e.g. SAT scores) and need for cognition (Cacioppo et al., 1996). (See Lauriola

& Levin, 2001; Levin et al., 2002; and Stanovich & West, 1998, for use of these scales in studies of decision making.) Young children, of course, cannot fill out these scales. We were fortunate, however, to have access to a population of children who have been the subject of continuous investigation since they were nine to ten months of age.[1] Kochanska and her colleagues have conducted a series of studies of the social and moral development of these children, obtaining a wide array of behavioral observations and parental reports (Kochanska, Coy, & Murray, 2001; Kochanska et al., 1998). In order to parallel the measures used to account for individual differences in the adult research, we included measures of cognitive ability, impulsivity, shyness, fearfulness, and thrill-seeking, all of which appear to have reached stable levels in these children (Grazyna Kochanska, personal communication, 20 August 2000).

Method

Pilot study

The procedures for obtaining risk-taking measures were first tested in a pilot study with a total of 15 children (2 girls, 13 boys). These children were recruited from local-area preschools and were not part of Kochanska's longitudinal study. Therefore, no temperament data existed for the pilot-study children. Ages ranged from 48 months to 74 months, with a mean of 58.87 and a standard deviation of 9.30. Four-year-olds were included in the pilot study even though the youngest age of children in the main study was five. If we could design tasks that could be easily understood by 4-year-olds, then we could reasonably be assured that the 5- and 6-year-olds in the main study would have no difficulty.

Main study children

Thirty children (19 girls, 11 boys) participated. Subjects were obtained from a normal population of 5- and 6-year-olds whose emotional, social, and cognitive development have been followed in earlier studies. Ages were much more homogeneous for this population than in the pilot study. Ages at the time of participation ranged from 69 months to 78 months, with a mean of 72.60 and a standard deviation of 2.27.

Procedure

Five gain trials and five loss trials were counterbalanced across children so that half received gain trials first and half received loss trials first. (Order of presentation of gain and loss trials was not a significant factor in any of the statistical analyses and will not be referred to again.) All children were seen in individual sessions that lasted approximately 15 minutes.

Domain of gains. Each child received five gain trials. Two experimenters were present during the session. Children were asked if they would like to play a game in which prizes could be won. (All agreed.) The rules of the game were explained to the child by the first experimenter until both experimenters were certain the child understood them. The child was then asked to explain the rules in his or her own words to the experimenters. The child and the first experimenter sat at a table on which four boxes were placed. The table measured 117×58 centimeters. Each box was $46 \times 30 \times 23$ centimeters. All boxes were identically decorated to control for possible preference effects of color or design of boxes. Two boxes were grouped on the left side of the table and two boxes were grouped on the right side, with the child positioned centrally between them.

The second experimenter sat at the same table opposite the child and Experimenter 1. Experimenter 1 turned the child's chair around while Experimenter 2 placed one prize under each box grouped on the left

[1]The authors are extremely grateful to Professor Grazyna Kochanska who has provided us with a population of children for whom a rich array of background data was available, making these data available to us, and helping us recruit these children for our own study.

side and two prizes under only one of the boxes grouped on the right side. For the first trial, these became the riskless and risky sides, respectively. The child was asked to choose from which side of the table they wanted to open a box, the side representing the sure gain of one prize or the side representing the uncertain outcome of two or zero prizes. On each successive trial, riskless and risky sides were switched.

All prizes were wrapped in paper of various colors and designs. The prizes ranged in size from a 20×28 centimeter coloring book to a 2×2 centimeter glow-in-the-dark ring. Children were instructed not to open any of the prizes until they left the laboratory. (Keeping the prizes wrapped prevents gender differences in perceived attractiveness.) The children were allowed to keep the prizes won on each trial.

Domain of losses. Each child received five loss trials. Methods were identical to those in the gain trials with the following exceptions. Only two boxes were placed on the table, one on the left side and one on the right. A pile of ten gift-wrapped prizes was placed between the two boxes. It was explained to the child that all 10 of the prizes are hers or his for now, but that during the course of the game she or he may lose some of the prizes. The purpose of this was to heighten feelings of loss for the child as prizes were taken away so that a truer loss domain could be created.

Two frown faces with the number 'one' on the nose were placed in the box on one side. In the box on the other side was placed one frown face with the number 'two' on the nose and one happy face with a 'zero' on the nose. These boxes represented the riskless and risky sides, respectively. The child was asked to choose from which box they wanted to draw a face. He or she was then instructed to hide their eyes and reach into the box to pull out a face. If the child chose the riskless side, he or she would extract a frown face with the number 'one' on the nose and Experimenter 2 would take away one prize from the pile. If the child chose the risky side, he or she would extract either a frown face with the number 'two' on the nose or a happy face with 'zero' on the nose and Experimenter 2 would take away either two prizes or no prize from the pile. The children were allowed to keep the prizes that remained at the end. As in the domain of gains, riskless and risky sides were switched after every trial.

Dependent variables

Two main measures of risk taking and two derived measures were obtained for each child: (1) number of risky choices to achieve a gain; (2) number of risky choices to avoid a loss; (3) total number of risky choices (gains plus losses); and (4) number of risky choices on loss trials minus number of risky choices on gain trials. The derived measures are of particular interest because they represent the overall tendency to make risky choices and the tendency for risky choices to differ in the domains of losses and gains. The latter is our operational definition of 'preference shift'.

Predictor variables

Gender. Because differences in risk taking for males and females are generally found in the adult literature (see recent review by Byrnes, Miller, & Schafer, 1999), gender was included in our analysis.

Measures of individual differences in temperament. While this aspect of our study is exploratory in nature, we selected those temperament traits from the set collected during the child's history of research participation that seemed to be logically related to risky decision making. Furthermore, as will be discussed later, these traits appear to be analogous to those found to have predictive ability in the earlier adult studies. The most recent measurement of each of these indices of temperament was at 45 months of age.

Fearfulness. Fearfulness is a temperament trait measured by degree of willingness to participate in new activities. In the earlier work with the main population, a room was filled with strange objects and a costumed person unknown to the child came in to play with him/her. The child's willingness to play with

the costumed stranger was recorded. Fearfulness became a stable trait after 22 months. Fearfulness was included because it focuses on reactions to negative or novel stimuli and thus appears to be related to the 'Big Five' trait of neuroticism (Rusting, 1998). Neuroticism, in turn, has been related to risk taking in adults (Lauriola & Levin, 2001; Levin et al., 2002).

Impulsivity. Impulsivity is a temperament trait measured by maternal response to a questionnaire. Example items include: 'Tends to say the first thing that comes to mind, without stopping to think about it;' 'Often rushes into new situations;' and 'Is slow and unhurried in deciding what to do next [reverse-keyed].' Because of its tie to decision making, it was a natural factor to include.

Thrill-seeking (high intensity pleasure). Thrill-seeking is a temperament trait measured by maternal response to a question ('Likes to play so wild and recklessly that s/he might get hurt') and by behavioral response to intense physical stimulation (e.g. being thrown and caught in mid-air). Thrill-seeking was included because prior research has linked this to risk taking (Dahlback, 1990).

Shyness. Shyness is a temperament trait that is measured by questionnaire-based items such as: 'Seems to be at ease with almost any person;' and 'Is comfortable asking other children to play.' Shyness was included because of its potential link to the Big Five traits of extroversion and openness to new experience, each of which has been related to risk taking (Levin et al., 2002).

Cognitive ability. Cognitive ability is measured by Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R). This is an individually administered, norm-referenced, standardized test to assess intelligence for children aged three to seven years. Two scales of the Verbal subtests (Information scale and Digit Span scale) were administered. Most recent measurement of cognitive ability was at 56 months. Cognitive ability was included because it can provide direct evidence as to whether cognitive limitations play a role in why decision makers react differently to nominally equivalent changes in outcome.

Results and discussion

Aggregate results

Aggregate data will be presented both for the main population of children ($n = 30$) because they are the focus of the study of individual differences and for the larger sample consisting of the main population plus the 15 pilot subjects whose treatment was virtually identical to that of the main population.

Preference shifts. Children in the main population were more risk-seeking to avoid a loss than to achieve a gain ($M = 4.13$ vs. 2.63 risky choices out of five trials of each type; $t(29) = 4.58$, $p < 0.001$). When the pilot subjects were added, the new means were 3.93 for losses and 2.64 for gains, $t(44) = 4.60$, $p < 0.00$l. It is worthy of note, however, that even in the gain domain over half the choices were of the risky option.

The frequency distribution of difference scores shows that the mean differences are representative of data for individual children. The majority of children (29 out of 45, or 64%) had positive scores for loss—gain trials; 9, or 20%, had zero differences; and only 7, or 16%, had negative difference scores.

Gender differences. For the main population of 30 children, boys chose the risky option more often than girls ($M = 8.18$ vs. 5.95 out of ten when combining gain and loss trials; $t(28) = 3.11$, $p < 0.005$). When the 15 pilot subjects were added, however, the mean difference failed to achieve statistical significance ($M = 7.01$ vs. 6.09, $t(44) = 1.36$).

Table 1. Correlation matrix between individual difference variables and measures of risk taking (Experiment 1)

	Gains	Losses	Total number of risky choices	Preference shift
Gender	0.36*	0.25	0.39*	−0.08
Fearfulness	0.24	−0.002	0.15	−0.19
Shyness	−0.32*	−0.38*	−0.45**	−0.05
Impulsivity	0.12	0.42*	0.35*	0.25
Thrill-seeking	0.11	0.33*	0.28	0.18
Cognitive ability	−0.21	0.25	0.02	0.34

$n = 30$.
*Indicates correlation is significant at 0.05 level (1-tailed).
**Indicates correlation is significant at 0.01 level (1-tailed).
In coding sex, girls = 1; boys = 0.
Total number of risky choices equals number of risky choices on gain trials plus number of risky choices on loss trials.
Preference shift equals number of risky choices to avoid a loss minus number of risky choices to achieve a gain.

Individual differences

For the main population, Table 1 shows the correlation between each predictor variable and each criterion variable (number of risky choices on gain trials, number of risky choices on loss trials, the sum of these two, the difference between these two). While we selected individual difference measures that appear logically related to risky decision making, the tests reported in Table 1 reflect our desire to cast a wide net in looking for relations. To provide an overview, we report that the set of predictor variables, as a whole, accounted for a significant proportion of the variance in total number of risky choices ($R^2 = 0.45$) but not in the difference in number of risky choices between loss trials and gain trials.

Impulsivity was positively related to overall risk taking and shyness was negatively related to risk taking: Children who scored high on impulsivity and those who scored low on shyness were more risk taking. Overall, boys were more risk taking than girls but difference scores were unrelated to gender.

Interestingly, cognitive ability, as measured by the WPPSI-R intelligence test, was positively related to preference shift, meaning that the children scoring higher on intelligence were more apt to show a preference shift than children scoring lower. This argues against a cognitive-limitations account of the differential reaction to gains and losses.

Summary

These results can be summarized in the following ways: (1) what they tell us about the feasibility of studying risky decision making in young children; (2) what they tell us about the comparability of risk taking in children and adults; and (3) what they tell us about individual differences in risk taking.

We were able to demonstrate that children as young as four years old can understand and follow the procedures for a risky decision-making task. In contrast to much of the research with adults and older children, which used scenario formats, the current procedure involved concrete choices that led to real consequences. The children clearly discriminated between choices to achieve gains and choices to avoid losses.

The aggregate results for the children are clearly in keeping with earlier findings with adults that decision makers are more willing to take risks to avoid a loss than to achieve a gain of the same magnitude. Nevertheless, these results fail to replicate the classic 'reflection effect' found in Tversky and Kahneman's (1981) Asian disease problem and other related problems where there is a literal reversal between preference for the riskless option in the domain of gains and preference for the risky option in the domain of losses. By contrast, the present results do not show preference for the riskless option on gain trials. Thus, there seems to be an overlaying of two tendencies in the present results: overall preference for the risky option and shift in degree of preference across domains. The contrast in results between Experiment 1 and earlier research could be due to some combination of task differences and differences between children and adults. Consequently, in Experiment 2 we hold the task constant but include both children and adults (parents).

While the overall tendency for young children to make more risky than riskless choices is consistent with the findings of Reyna and Ellis (1994), the preference shift is not. Reyna and Ellis found that reliable preference shifts do not emerge until late childhood, and that younger children are 'more rational' than older children and adults in response to gambles of equal expected value. Preschoolers were consistent across gain and loss frames, while older children were not. In that study, unlike the present study, the children did not literally have prizes added or taken away on each trial. All children received a single prize at the end of the session. In a study by Schlottmann (2000), however, many children showed risk seeking and risk avoidant patterns similar to those found in adults. In that study, a 'relevant-involvement' method was used to assess children's understanding of probability by asking children to judge how happy a puppet playing the game would be. The relevant involvement method entails making the task meaningful to children by using concrete tasks, such as a competitive game in which prizes are won, which tap into abstract concepts. This can help to ensure optimal understanding and increased motivation (see Falk & Wilkening, 1998, for a brief review). In the present study, we also use a relevant-involvement method. Children won or lost prizes as an immediate consequence of their choices. This could have led to greater differentiation of gain and loss trials.

Individual differences in the present study can be related to those found in adult studies. Impulsivity was positively related to risk taking in young children, and shyness was negatively related. In Levin et al. (2002), openness to new experience was positively related to risk taking in adults. These results seem compatible. If childhood temperament measures are precursors of adult personality traits, then the present results reveal that similar processes may be operating in child and adult risky decision making. Furthermore, they suggest that childhood measures can predict individual differences later in life. (See Eder & Mangelsdorf, 1997, for a more general review of personality development.) Experiment 2, with a larger sample size, provides more powerful tests of this proposition.

EXPERIMENT 2

While the special population of children in Experiment 1 was useful for suggesting predictors of individual differences in risk taking, it was limited in size. Experiment 2 replicates some of the main results of Experiment 1 with a larger sample. In place of the historical data available for the children in Experiment 1, a new element was added to provide more evidence of the antecedents of risky decision making in children. The parent accompanying each child was given exactly the same task as the child. This new feature allows us to accomplish the following: (1) demonstrate that the task developed to study risk preference shifts in children does in fact capture the essence of the phenomenon observed in adults; (2) allow comparison of preference shifts in adults and children; and (3) show the extent to which risky choice behavior in an individual child can be predicted by the behavior of that child's parent. Parents also filled out a survey of their child's behavior that gets at some of the same traits measured in Experiment 1.

Another addition to Experiment 2 is that, like Reyna and Ellis (1994), we include the manipulation of probability level. Each child receives gain and loss trials with a probability of winning or losing of 0.50 and trials with a 0.20 probability. Probability information is conveyed simply, by varying the number of boxes from which the child must choose. This allows us to see whether children are sensitive to probability differences and, if they are, whether their sensitivity to this dimension is the same as adults'.

Method

Participants

Seventy-two child–parent pairs participated. The sample consisted of 39 girls and 33 boys, 57 mothers and 15 fathers. Ages at the time of participation ranged from 72 months to 94 months, with a mean of 83.00 and a standard deviation of 5.99. (Within this limited age range, age was not a factor in any of the analyses and will not be discussed further.) Participants were recruited from the child research participant pool at the University of Iowa Department of Psychology.

Design

In addition to the manipulation of gain–loss domain, degree of risk was manipulated. Within each domain a block of three trials was given where a sure-thing option was paired with a 50:50 risky choice. This is a replication of Experiment 1. Also within each domain, a block of three trials was given where a sure-thing option was paired with a 20:80 risky choice of equal expected value. On win trials a choice was made between a sure gain of one and a 1-in-5 chance of winning five; on loss trials a choice was made between a sure loss of one and a 1-in-5 chance of losing five.

Procedure

All experimental sessions were administered individually and lasted approximately 20 minutes. Procedures were similar to those used in Experiment 1, with the main exception being that parents participated in the same tasks and were given the same instructions verbatim as the children (but in separate sessions). The tasks were presented as a game of chance in which dimes could be won or lost. This is a bit of a departure from Experiment 1 where prizes were given, but with a larger range of possible outcomes in Experiment 2, prizes would be cumbersome. The size of the boxes was scaled down accordingly. The domain of gains consisted of three trials for each probability (50:50 and 20:80) and the domain of losses consisted of three trials for each probability. The order of presentation was randomized across domains and probability levels. (Order of presentation of gain and loss trials and probability level was not a significant factor in any of the statistical analyses and will not be referred to again.)

Domain of gains. Each participant received three trials under a 50:50 probability and three trials under a 20:80 probability. In the 50:50 condition, participants chose between the sure option of winning one dime and the risky option in which they had a 50% chance of winning two dimes and a 50% chance of winning no dime. Two boxes were grouped on the left side of the table and two boxes were grouped on the right side, representing the risky and riskless alternatives. A token representing the number of dimes to be won was placed under each box. Participants were instructed to 'hide your eyes' while the tokens were being placed under the boxes. On the risky side, a token with a happy face saying 'win two' was placed under one of the boxes and a token with a frown face saying 'win zero' was placed under the other box. On the riskless side, a token with a neutral face saying 'win one' was placed under each box.

In the 20:80 condition, they chose between the sure option of winning one dime and the risky option in which they had a 20% chance of winning five dimes and an 80% chance of winning nothing. Five boxes were grouped on the left side of the table and five boxes were grouped on the right side, representing the risky and riskless alternatives. A token representing the amount of dimes to be won was placed under each box. On the risky side, a token with a happy face saying 'win five' was placed under one of the boxes and a token with a frown face saying 'win zero' was placed under each of the remaining four boxes. On the riskless side, a token with a neutral face saying 'win one' was placed under each box.

The task was a two-stage decision process. Participants were first instructed to choose which side they wanted to play from, the 'side where you win one dime for sure, or the side where you might win two (five) dimes or you might win no dime.' To ensure that participants had at least an intuitive understanding of the odds, they were asked to relate to the experimenter the total number of boxes on each side, the number of boxes that had a favorable outcome, an unfavorable outcome, and the number of dimes that could be won. For example, if the risky side was chosen the experimenter said, 'I see you picked this side. Tell me how many boxes are on this side. How many of these boxes are winning boxes? How many dimes can you get from the winning boxes? How many boxes are there where you don't win?' Next, they were instructed to choose which box they wanted and lift it up to reveal the token. Participants received their winnings after each trial.

Domain of losses. Each participant received three trials under a 50:50 probability and three trials under a 20:80 probability. In the 50:50 condition, participants chose between the sure option of losing one dime and the risky option in which they had a 50% chance of losing two dimes and a 50% chance of losing nothing. Two boxes were grouped on the left side of the table and two boxes were grouped on the right side, representing the risky and riskless alternatives. (Note that the procedures for gain and loss trials were more nearly identical in Experiment 2 than they were in Experiment 1.) A token was placed under each box representing the number of dimes to be lost. On the risky side, a token with a frown face saying 'lose two' was placed under one of the boxes and a token with a happy face saying 'lose zero' was placed under the other box. On the riskless side, a token with a neutral face saying 'lose one' was placed under each box.

In the 20:80 condition, they chose between the sure option of losing one dime and the risky option in which they had a 20% chance of losing five dimes and an 80% chance of losing nothing. Five boxes were grouped on the left side of the table and five boxes were grouped on the right side, representing the risky and riskless alternatives. A token representing the amount of dimes to be lost was placed under each box. On the risky side, a token with a frown face saying 'lose five' was placed under one of the boxes and a token with a happy face saying 'lose zero' was placed under each of the remaining four boxes. On the riskless side, a token with a neutral face saying 'lose one' was placed under each box.

Dimes could not be taken from previous winnings because half the participants received loss trials first. Instead, a 'bank' of dimes was placed between the sets of risky and riskless boxes. In the 50:50 condition the bank consisted of six dimes. In the 20:80 condition the bank consisted of fifteen dimes. These were the total number of dimes that could be lost if the participant was unlucky on all three trials. Participants were told that the bank of dimes was theirs, but that they might lose some in the course of the game.

As in the domain of gains, the task was a two-stage decision process. Participants were first instructed to choose which side they wanted to play from, the 'side where you lose one dime for sure, or the side where you might lose two (five) dimes or you might lose no dime.' They were asked to relate to the experimenter the total number of boxes on each side, the number of boxes that had a favorable outcome, an unfavorable outcome, and the number of dimes that could be lost. Next, they were instructed to choose which box they wanted and then to lift it up to reveal the token. Dimes were taken from the participant's bank after each trial.

Dependent variables

As in Experiment 1, two main measures of risk taking and two derivative measures were obtained for each child: (1) number of risky choices to achieve a gain; (2) number of risky choices to avoid a loss; (3) total number of risky choices (gains plus losses); and (4) number of risky choices on loss trials minus number of risky choices on gain trials. Again, the emphasis is on the last two measures because they reflect overall risk taking and the preference shift.

Predictor variables

Parents' risky decision-making preferences. The same four measures of risk taking as were used with the children were obtained for each parent.

Measures of individual difference. In examining the relationship between individual differences and risky decision making, we conducted two different sets of analyses: (1) correlating with risk measures the factor scores from the Child Behavior Questionnaire (CBQ) (Rothbart, Ahadi, & Hershey, 1994) based on factor loadings provided by Rothbart et al. (2001); and (2) correlating individual scale scores from the CBQ.

Parents filled out the CBQ. The CBQ is a 195-item parent-report instrument assessing temperament in 3- to 7-year-old children across 15 scales (Rothbart et al., 1994). This measure has demonstrated excellent internal consistency, with alphas = 0.67 to 0.94 and a mean internal consistency estimate of 0.77 across

all 15 scales (Ahadi, Rothbart, & Ye, 1993). This measure has also demonstrated stability across time, with *r*s = 0.50 to 0.79 and a mean stability estimate of 0.65 across scales (Rothbart et al., 2001). Convergent validity in terms of parental agreement is a crucial factor because the majority of our participating parents were mothers. Rothbart et al. (2001) found that correlations between mother and father reports ranged from 0.28 to 0.79, with a mean agreement across scales of 0.51. This indicates substantial parental agreement and suggests that our CBQ scores were not skewed as a result of having mostly mothers filling out the CBQ.

Based on factor loadings developed by Rothbart et al., we computed the three-factor scores (Negative Affectivity, Extraversion, Effortful Control) in our sample. We then correlated these factor scores with the four risky decision-making indices (number of risky choices in gains, losses, total number of risky choices, and number of risky choices in losses minus gains). In our sample, these correlations were not significant, probably because some of the individual scales composing each factor were unrelated to our measures. Similar to the logic used in Experiment 1, we then selected from the CBQ a subset of individual scale scores (defined below) that seemed to logically relate to risky decision making. We especially included factors shown to predict behavior in Experiment 1: shyness and impulsivity.

Approach measures the degree to which expected pleasurable activities are positively anticipated. *Fear* measures the degree to which potentially distressing or threatening situations are negatively anticipated. *High intensity pleasure* measures the degree of enjoyment associated with highly stimulating activities. *Impulsivity* measures the rate of response initiation. *Sadness* measures the degree of negative affect associated with object loss, disappointment or suffering. *Shyness* measures the degree to which approach to novel situations is inhibited.

Results and discussion

Aggregate results

Preference shifts. Table 2 shows that the results of Experiment 1 were replicated with the much larger sample of children in Experiment 2. Again, the majority of choices were risky, even in the domain of gains. However, children were more risk-seeking to avoid a loss than to achieve a gain for trials with 0.50 probability, $t(71) = 7.17$, $p < 0.001$ and for trials with 0.20 probability, $t(71) = 7.40$, $p < 0.001$.

Parents were also more risk-seeking to avoid a loss than to achieve a gain for 0.50 probability level, $t(71) = 3.40$, $p < 0.001$ and for 0.20 probability, $t(71) = 9.58$, $p < 0.001$.

The frequency distribution of difference scores shows that the mean differences are representative of data for individual children. For 0.50 probability level, 50% of the children had positive difference scores, and 50% had zero differences. For 0.20 probability, the majority of children (43 out of 72, or 60%) had positive difference scores, 25 (36%) had zero differences and only 3 children (4%) had negative difference scores.

In the parent population, we found the following preference shifts. For 0.50 probability, 30 out of 72, or 42%, had positive difference scores, 31 (43%) had zero differences, and 11 (15%) had negative difference scores. For 0.20 probability, 49 (68%) had positive difference scores, 22 (31%) had zero differences, and only one parent had a negative difference score.

Analyses of variance show the commonalities and differences between the pattern of risk taking for children and their parents. The three-way ANOVA for member (child vs. parent) by domain (gain vs. loss) by

Table 2. Mean number of risky choices (and standard deviations) in Experiment 2 (out of three trials for each type)

	Children		Parents	
	$P = 0.5$	$P = 0.2$	$P = 0.5$	$P = 0.2$
Gain trials	2.01 (s.d. = 0.80)	1.96 (s.d. = 0.91)	1.76 (s.d. = 1.16)	1.36 (s.d. = 1.10)
Loss trials	2.63 (s.d. = 0.66)	2.78 (s.d. = 0.56)	2.31 (s.d. = 0.99)	2.65 (s.d. = 0.77)

probability ($P = 0.5$ or 0.2) showed the following significant results: a main effect for domain $F(1, 71) = 129.05$, $p < 0.001$, with more risky taking for losses than for gains; a main effect for member, $F(1, 71) = 13.14$, $p < 0.001$, with more risk taking overall for child than parent; a domain by probability interaction $F(1, 71) = 17.86$, $p < 0.001$, with the difference in risk taking between losses and gains being greater for $P = 0.2$ than for $P = 0.5$, and a member by domain by probability interaction, $F(1, 71) = 5.00$, $p = 0.028$. (As can be seen in Table 2, some response rates were close to the ceiling level of 3.0 and this could have affected the three-way interaction.) The three-way interaction was then broken down by doing separate two-way ANOVAs for children and parents. For children, the domain effect was significant, $F(1, 71) = 90.46$, $p < 0.001$, but neither probability nor domain by probability was significant. For adults, the domain effect was significant, $F(1, 71) = 69.28$, $p < 0.001$, and the probability effect was not but the domain by probability interaction was significant, $F(1, 71) = 14.56$, $p < 0.001$. Adults, but not children, showed a stronger preference shift at $P = 0.2$ than at $P = 0.5$. Notably, the member by domain interaction was not significant, meaning that the overall magnitude of the preference shift was not significantly different for children and parents.

These results may be due to the fact that at 0.20 probability, compared to 0.50 probability, there is a smaller chance of achieving gains but also a smaller chance of suffering losses. The stronger preference shift at 0.20 in parents may, therefore, be a reflection of their greater focus on the probability dimension. General conclusions from the developmental literature are that young children (4–5) do not understand probability, and will concentrate on one aspect of the problem (the number of winning elements) to the exclusion of the other critical aspect of the problem (the number of losing elements) (Piaget & Inhelder, 1975 [1951]; Siegler, 1981). Falk and Wilkening (1998) have also found unidimensional thinking in all but the oldest age group (13-year-olds).

In contrast to the traditional view that probability understanding emerges late in development, Schlottmann (2001) found that children as young as five have an intuitive understanding of probability and expected value (EV) when a relevant-involvement method was used rather than the traditional binary-choice paradigm. In that study, children judged EV of complex gambles by judging how happy a puppet would be to play the game, and won prizes according to the outcome. The present results show that the children responded less to changing risk levels than did adults, but, of course, if they completely ignored probabilities, they would have made 100% risky choices in the domain of gains.

Individual differences

With the larger sample size in Experiment 2, regression analyses were conducted to determine the contributions of the predictor variables. The regression analyses for total number of risky choices and the difference in number of risky choices between the loss and gain domains are summarized in Table 3. (Also included are the separate regressions for gains and losses that show that individual difference factors were more likely to predict responses on gain trials than on loss trials. The high level of risk taking on loss trials led to less variance to explain.) Overall $R^2 = 0.22$ for total number of risky choices. That is, the predictor variables consisting of child's gender, parent's total score, and the six subscales of the CBQ accounted for 22% of the variance in the child's total score. The parent's total number of risky choices was positively related to the child's. The more risk-taking the parent, the more risk-taking the child. In addition, the child's scores on the approach scale and the shyness scale tended to be negatively related to risk taking ($0.05 < p < 0.10$), meaning that the more shy the child is and the more positively the child reacts to expected pleasure the less likely s/he is to make the risky choice.

The predictor variables for the difference in number of risky choices between loss and gain trials consisted of the same set as for total risky choices, except that the parent's difference score was used instead of the parent's total score. Overall $R^2 = 0.33$ for preference shift. The significant predictors were the CBQ subscales of shyness, sadness, impulsivity, and approach. Children scoring higher on shyness, impulsivity, and approach, and children scoring lower on sadness show the largest preference shift.

Table 3. Prediction of risk taking in Experiment 2

Dependent variable: number of risky choices to achieve a gain			
	ΔR^2	*t* each predictor	β
Step 1.	0.00		
Sex of child		−0.05	−0.01
Step 2.	0.07*		
Parent's # of risky choices		2.20*	0.27
Step 3.	0.23**		
Approach		−2.35*	−0.32
Fearfulness		−1.24	−0.17
Thrill-seeking		−0.67	−0.1
Impulsivity		−1.44	−0.21
Sadness		2.09*	0.28
Shyness		−2.94**	−0.45
Dependent variable: number of risky choices to avoid a loss			
	ΔR^2	*t* each predictor	β
Step 1.	0.06*		
Sex of child		−2.02*	−0.24
Step 2.	0.04		
Parent's # of risky choices		1.56	0.19
Step 3.	0.04		
Approach		−0.62	−0.09
Fearfulness		−0.95	−0.16
Thrill-seeking		−0.78	−0.13
Impulsivity		0.77	0.13
Sadness		−0.25	−0.04
Shyness		0.76	0.13
Dependent variable: total number of risky choices			
	ΔR^2	*t* each predictor	β
Step 1.	0.02		
Sex of child		−1.00	−0.12
Step 2.	0.08*		
Parent's # of risky choices		2.40*	0.29
Step 3.	0.12		
Approach		−1.80	−0.25
Fearfulness		−1.13	−0.17
Thrill-seeking		−0.80	−0.13
Impulsivity		−0.51	−0.08
Sadness		1.16	0.16
Shyness		−1.48	−0.24
Dependent variable: preference shift			
	ΔR^2	*t* each predictor	β
Step 1.	0.04		
Sex of child		−1.56	−0.19
Step 2.	0.02		
Parent's # of risky choices		1.03	0.13
Step 3.	0.28**		
Approach		2.15*	0.28
Fearfulness		0.48	0.07

Continues

Table 3. Continued

Thrill-seeking	0.07	0.01
Impulsivity	2.36*	0.34
Sadness	−2.50*	−0.33
Shyness	4.03**	0.61

$n = 72$.
*Indicates significant at 0.05 level.
**Indicates significant at 0.01 level.
In coding sex, girls = 1; boys = 0.
Total number of risky choices equals number of risky choices on gain trials plus number of risky choices on loss trials.
Preference shift equals number of risky choices to avoid a loss minus number of risky choices to achieve a gain.

The degree of preference shift exhibited by the child's parent was not a significant factor. Given that the total number of risky choices is reflective of a general attitude toward risk whereas the preference shift represents a more specialized differential reaction to losses and gains, it seems reasonable that the general attitude is more cross-generational than the specialized reaction.

It is also worth noting that the child's gender entered as a significant factor in only one of the four measures (losses) in Experiment 2. Recall that it was equivocal in Experiment 1. Slovic (1966) found evidence of more risk taking by boys than by girls, but only after age nine.

Summary

By including parents in this experiment we were able to meet the following objectives: (1) show that adults receiving the 'child friendly' version of the risky decision making task exhibited the typical preference shift, thus supporting the validity of the task for comparing preference shifts in adults and children; (2) show that the extent of preference shift is comparable in children and adults even though not all variables (e.g. probability of risky option) have identical effects; and (3) show that the parent's performance in the risky decision making task is a significant predictor of their child's performance, at least with respect to tendency to make risky choices. In addition, the CBQ provided new evidence that personality and temperament are reliable predictors of risky decision making even at an early age.

CONCLUSIONS

Across both experiments and the pilot study, 117 children were tested for the preference shift and strong support was provided for the prediction that more risky choices would be made to avoid losses than to achieve gains. In Experiment 1 (including the pilot data), four times as many children exhibited the predicted shift as exhibited a shift in the opposite direction. In Experiment 2 this ratio was over 10-to-1. On the basis of Experiment 1 alone, it could be argued that the changes we made to the typical risky choice task make it difficult to compare these results to those found in the adult literature and thus difficult to conclude that similar processes operate for children and adults. Experiment 2 overcame this difficulty by showing that the same twofold pattern of overall preference for the risky option but more so for loss trials than for gain trials occurred for parents and children receiving the same task. The general tendency to make risky choices may be tied to the game-like structure of the task. There is more excitement for child and parent to pick boxes from the risky side of the table, and the stakes are not high enough to cause risk-aversion. The greater preference for risky choices in the domain of losses than in the domain of gains is consistent with the value function of prospect theory that is concave in the domain of gains and convex in the domain of losses

(Kahneman & Tversky, 1979). However, prospect theory alone cannot account for the complete set of results without providing for task-specific differences in attitude toward risk.

One key aspect of the task received by both children and their parents that adds validity to the results is that participants experienced the consequences of their choices by means of immediate gains or losses. This feature, as well as the use of parents as matched controls, has not characterized much of the earlier work on decision making in children. We, therefore, conclude that the phenomenon of greater risk taking to avoid losses than to achieve gains develops at an early age and is a fundamental finding for children as well as for adults.

Another new aspect of this study is the attempt to discover individual differences in childhood traits that predict choices in our task and that may relate to analogous predictors of adult risky decision making. Comparisons between the results for the present experiments and the adult studies of individual differences in risky choice yielded some interesting commonalities.

Shyness was negatively related to risk taking in both experiments. The tendency to be especially more risk taking in the domain of losses than in the domain of gains was characteristic of children with greater shyness and impulsivity, but less sadness. In the adult studies using the Big Five personality inventory, openness to new experiences was predictive of risk taking and high neuroticism was predictive of greater preference shift (Lauriola & Levin, 2001; Levin et al., 2002). To the extent that childhood sadness and adult neuroticism tap into similar processes, and that childhood shyness and adult openness or disinhibition are inversely related, the present results are consistent with these earlier adult studies. The adult traits were selected specifically because they relate to the differential reaction to positive and negative stimuli (Rusting, 1998; Levin et al., 2002). Thus the present results support the proposition that individual differences in this differential reaction are part of the underlying process of risky decision making.

In this study we set out to develop a method by which we could compare risky choices for gains and losses in young children. Key elements of the task were that children were easily able to understand risk level by simple counting procedures and that similar principles were involved in implementing gain and loss trials. Furthermore, we hoped to capture the variance in responses through individual differences in childhood temperament and personality. The reliability of the main findings across experiments and the ability to account for significant proportions of the variance in response through measures of temperament point to the usefulness of the task and measures.

We feel that the adaptation of traditionally adult decision-making tasks to children can extend our understanding of the development of some of the 'classic' decision biases and heuristics. We recommend inclusion of some of the design features illustrated in the present study: use of real consequences as opposed to hypothetical scenarios, use of parents as a natural 'control' group as well as a predictor of the performance of individual children, and inclusion of various other indices to determine the extent to which dispositional traits predict decision making in children as well as in adults.

ACKNOWLEDGEMENTS

Parts of this paper were presented at the 2001 meeting of the Society for Judgment and Decision Making, Orlando, Florida, and the 2002 meeting of the Society for Judgment and Decision Making, Kansas City, Missouri.

This research was supported by National Science Foundation Grants No SES 00-01316 and SES 02-17620, and Spelman-Rockefeller program grant administered through the University of Iowa's Obermann Center for Advanced Studies.

The authors would like to thank the following students for aiding in the development and conduct of the research sessions: Kelly Curtis, Kate Nichols, Elizabeth Shefter, Sarah Vinson, Jessica Wagner, Megan Bretthauer, and Katie Hietpas.

REFERENCES

Agnoli, F. (1991). Development of judgmental heuristics and logical reasoning: training counteracts the representativeness heuristic. *Cognitive Development, 6*, 195–217.

Ahadi, S. A., Rothbart, M. K., & Ye, R. (1993). Children's temperament in the US and China: similarities and differences. *European Journal of Personality, 7*(5), 359–377.

Baron, J., Granato, L., Spranca, M., & Teubal, E. (1993). Decision-making biases in children and early adolescents: exploratory studies. *Merrill-Palmer Quarterly, 39*, 22–46.

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: a meta-analysis. *Psychological Bulletin, 125*, 367–383.

Cacioppo, J. T., Petty, R. E., Feinstein, J., & Jarvis, W. (1996). Dispositional differences in cognitive motivation: the life and times of individuals varying in need for cognition. *Psychological Bulletin, 119*, 197–253.

Dahlback, O. (1990). Personality and risk-taking. *Personality and Individual Differences, 11*, 1235–1242.

Davidson, D. (1991). Children's decision-making examined with an information-board procedure. *Cognitive Development, 6*, 77–90.

Davidson, D. (1996). The effect of decision characteristics on children's selective search of predecisional information. *Acta Psychologica, 92*, 263–281.

Digman, J. M. (1990). Personality structure: emergence of the five factor model. *Annual Review of Psychology, 44*, 417–440.

Eder, R. A., & Mangelsdorf, S. C. (1997). The emotional basis of early personality development. In R. Hogan, J. Johnson, & S. Briggs (Eds.), *Handbook of personality psychology* (pp. 209–240). San Diego, CA: Academic Press.

Falk, R., & Wilkening, F. (1998). Children's construction of fair chances: adjusting probabilities. *Developmental Psychology, 34*(6), 1340–1357.

Harbaugh, W. T., Krause, K., & Vesterlund, L. (2000). *Subjective probability weights for children and adults over gains and losses*. Unpublished manuscript, University of Oregon.

Huber, B. L., & Huber, O. (1987). Development of the concept of comparative subjective probability. *Journal of Experimental Child Psychology, 44*, 304–316.

Jacobs, J. E., Greenwald, J. P., & Osgood, D. W. (1995). Developmental differences in base rate estimates of social behaviors and attitudes. *Social Development, 4*, 165–181.

Jacobs, J. E., & Potenza, M. (1991). The use of judgment heuristics to make social and object decisions: a developmental perspective. *Child Development, 62*, 166–178.

Kahneman, D., & Tversky, A. (1979). Prospect theory: an analysis of decision under risk. *Econometrica, 47*, 263–291.

Klaczynski, P. (2001). Analytic and heuristic processing influences on adolescent reasoning and decision-making. *Child Development, 72*, 844–861.

Kochanska, G., Coy, K. C., & Murray, K. T. (2001). The development of self-regulation in the first four years of life. *Child Development, 72*, 1091–1111.

Kochanska, G., Coy, K. C., Tjebkes, T. L., & Husarek, S. J. (1998). Individual differences in emotionality in infancy. *Child Development, 69*, 375–390.

Lauriola, M., & Levin, I. P. (2001). Personality traits and risky decision-making in a controlled experimental task: an exploratory study. *Personality and Individual Differences, 31*, 215–226.

Levin, I. P., Gaeth, G. J., Schreiber, J., & Lauriola, M. (2002). A new look at framing effects: distribution of effect sizes, individual differences, and independence of types of effects. *Organizational Behavior and Human Decision Processes, 88*, 411–429.

Marks, R. (1951). The effect of probability, desirability, and 'privilege' on the stated expectations of children. *Journal of Personality, 19*, 332–351.

Piaget, J., & Inhelder, B. (1975). *The origin of the idea of chance in children* (L. Leake, P. Burrell, & H. D. Fishbein, Trans.). Paris: Presses Universitaires de France. [Original work published 1951.]

Reyna, V. F., & Ellis, S. C. (1994). Fuzzy-Trace Theory and framing effects in children's risky decision making. *Psychological Science, 5*, 275–279.

Rothbart, M., Ahadi, S., Hersey, K., & Fisher, P. (2001). Investigations of temperament at three to seven years: the Children's Behavior Questionnaire. *Child Development, 72*, 1394–1408.

Rothbart, M. K., Ahadi, S. A., & Hershey, K. L. (1994, January). Temperament and social behavior in childhood. *Merrill-Palmer Quarterly, 40*(1), 21–39.

Rusting, C. L. (1998). Personality, mood, and cognitive processing of emotional information: three conceptual frameworks. *Psychological Bulletin, 124*(2), 165–196.

Schlottmann, A. (2000). Children's judgments of gambles. *Journal of Behavioral Decision Making, 13*, 77–89.

Schlottmann, A. (2001). Children's probability intuitions. *Child Development, 72*(1), 103–122.
Schlottmann, A., & Anderson, N. H. (1994). Children's judgments of expected value. *Developmental Psychology, 30*, 56–66.
Siegler, R. S. (1981). Developmental sequences within and between concepts. *Monographs of the Society for Research in Child Development, 46*(Whole No. 189).
Slovic, P. (1966). Risk-taking in children: age and gender differences. *Child Development, 37*, 169–176.
Stanovich, K. E. (1999). *Who is rational? Studies of individual differences in reasoning*. Mahwah, NJ: Lawrence Erlbaum Associates.
Stanovich, K. E., & West, R. F. (1998). Individual differences in rational thought. *Journal of Experimental Psychology: General, 127*, 161–188.
Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211*, 453–458.
Vollrath, M., Knoch, D., & Cassano, L. (1999). Personality, risky health behaviour and perceived susceptibility to health risks. *European Journal of Personality, 13*, 39–50.

Authors' biographies:

Irwin P. Levin is a Professor in the Department of Psychology and the Department of Marketing at The University of Iowa. His research interests include framing effects in decision making and individual differences in decision-making strategies in areas such as health decisions and consumer decisions.

Stephanie S. Hart is a third-year graduate student in the Department of Psychology at The University of Iowa. Her research interests are in the development of individual differences in judgment and decision making and in the cognitive bases of heuristics and biases.

Authors' addresses:

Irwin P. Levin and **Stephanie S. Hart**, Department of Psychology, The University of Iowa, 11 Seashore Hall E, Iowa City, IA 52242-1407, USA.

