THE ROLE OF FUTURE UNPREDICTABILITY IN HUMAN RISK-TAKING

Elizabeth M. Hill
The University of Detroit Mercy
The University of Michigan

Lisa Thomson Ross and Bobbi S. Low
The University of Michigan

Models of risk-taking as used in the social sciences may be improved by including concepts from life history theory, particularly environmental unpredictability and life expectancy. Community college students completed self-report questionnaires measuring these constructs along with several well-known correlates. The frequency of risk-taking was higher for those with higher future unpredictability beliefs and shorter lifespan estimates (as measured by the Future Lifespan Assessment developed for this study), and unpredictability beliefs remained significant after accounting for standard predictors, such as sex and temperament. The results demonstrate the usefulness of applying concepts from life history theory to enhance our understanding of human behavior.

KEY WORDS: **Community college students; Family unreliability; Future unpredictability beliefs; Life expectancy; Life history theory; Risk-taking; Socioeconomic resources.**

Life-course pathways can be differentiated by the risk of specific behaviors at certain developmental choice points, such as whether or not to marry, have a child, continue attending school, or engage in a crime. Effectiveness of risk-taking will depend on the present and future benefits and costs of the act, compared with available alternatives for obtaining economic and social resources for family formation and reproduction.

Received: February 18, 1997; accepted April 16, 1997.

Address all correspondence to Dr. Elizabeth M. Hill, Department of Psychology, The University of Detroit Mercy, 8200 West Outer Drive, Detroit, MI 48219. E-mail: hillem@udmercy.edu

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Human Nature, Vol. 8, No. 4, pp. 287–325. **1045-6767/97/$1.00+.10**

This view is not meant to imply that all choices made during life-course pathways are conscious or rational. However, conceptualizing life-course pathways in this way permits analysis of the effectiveness (i.e., costs and benefits) of risk-taking in specific environmental contexts. Factors that may influence a decision to take a risk include one's assessment of the future environment, especially the predictability and amount of future resources and one's subjective estimate of one's own future survival. Risk-taking may be more effective than conserving when the future is unpredictable; future negative consequences are discounted while potential immediate benefits are more salient. Two bodies of literature can be usefully integrated to understand risk-taking: psychological models of risk-taking and biological life history theory. Psychological theories of risk-taking have rarely incorporated characteristics of the life course, such as lifespan, timing of maturation, or reproductive decisions. Life history theory, developed to make sense of variation in reproductive patterns, has rarely been used to examine psychological characteristics that relate to reproduction or to risk-taking as a psychological aspect of behavior. This article attempts to combine these analytic frameworks to examine risk-taking as a general dimension (assumed to be correlated with reproductive decisions) in a context of human life history strategies. Economic models of risk-taking are also relevant where they can be applied to nonmonetary behavior. A full treatment of economic theory is beyond the scope of this article, however.

Life history theory, a subset of natural selection theory, argues that biological traits of lives (e.g., age at maturation) result from tradeoffs in allocating effort between survival and current reproduction; between current and future reproduction; and, within current reproduction, among offspring of different sex, size, and number. As in any zero-sum game, energy and resources that an organism spends in one endeavor cannot be spent in another. Life histories, or the patterns of birth, growth, and death, are thus the outcome of competing costs and benefits of different activities at any point in the life cycle. Two recent syntheses of life history theory (Roff 1992; Stearns 1992) identify the following life history traits as central to any analysis: size at birth, growth pattern, age and size at maturity, allocation of reproductive effort, age schedules of birth and death, and number and sex ratio of offspring. At any moment in time, an organism might spend its effort on maintaining its soma, or body (*somatic effort:* thermoregulation, eating, avoiding predators, etc.), or it might spend *reproductive effort,* either in attracting a mate (*mating effort)* or in caring for offspring (*parental effort).* In any particular environment, for an organism of a particular age, some patterns of expenditure are more effective than others in enhancing survival and reproduction. The tradeoffs among these traits (e.g., ener-

gy spent on reproduction cannot be spent on growth) lead to a variety of patterns in, for example, mating, parental care, and senescence.

Thus, life history theory offers a rich conceptualization of human reproductive behavior; life history theory can also be applied to risk-taking decisions in general. In this paper, forgoing a risky act is viewed as buying survival time (*sensu* Gardner 1993; Rogers 1994). Current psychological models of risk-taking do not include a life history perspective (with the notable exception of Gardner and Herman 1991 and Gardner 1993, described below).

ANALYTIC MODELS OF RISK-TAKING

Farley (1991) points out that risk-taking can be positive. For example, creativity, discovery, and invention rely on exploring the unknown, exposing oneself to uncertainty, and being willing to take a risk (Farley 1991). For the purposes of this paper, however, the focus will be on socially disapproved risk behaviors. At best, these behaviors involve undesirable or unwanted outcomes (e.g., unprotected sexual intercourse, truancy). At worst, they involve harmful or deadly consequences (e.g., smoking, drinking, other drug use, aggression). Yates and Stone (1992) conclude that the possibility of loss is inherent in a "risk." It should be noted that socially disapproved risk behaviors tend to cluster together, in the sense that people who engage in some risky behavior are also more likely to engage in other types of risky behavior. This has been demonstrated in adolescents (Biglan et al. 1990; Donovan and Jessor 1985; Rydelius 1983), young adults (Castro et al. 1989; Donovan and Jessor 1985; Osgood et al. 1988), and middle-aged (Hunt et al. 1992) as well as older (Leigh and Fries 1992) adults. Most research focuses on negative or potentially harmful risk-taking behaviors. However, some decisions are difficult to evaluate absolutely, and they may simply be alternative responses, rather than "bad" responses. A life history approach allows full consideration of risk-taking behavior, whether it has traditionally been viewed as positive or negative, and removes the judgmental or evaluative tone from a decision such as reproductive timing. Thus, risk-taking refers here to acts that could endanger survival, as discussed in more detail below.

Current psychological models used to predict risk-taking are based on expected utility theory (von Newmann and Morgenstern 1947), such as decision analysis (Yates 1990). Bromiley and Curley (1992) review existing approaches to individual differences in risk-taking. Trait-oriented research has been conducted by personality researchers, conceiving of risk-taking as risk-seeking. In contrast, decision theory ignores individual

differences and focuses on the characteristics of behavioral alternatives. Expected utility theory has been applied to risk situations to label individual differences in attitude toward risk (risk-seeking vs. risk-avoiding). Some attempts have been made to separate the value of reward (with no uncertainty) from the utility (with uncertainty). Another approach has considered individual differences in risk-taking as owing to variation in two motivations, desire for security, and desire for high return (Schneider and Lopez 1986). Bromiley and Curley (1992) note the lack of explanatory theories for individual differences.

An example of a psychological model is Furby and Beyth-Maron's (1992) decision-making analysis of a typical example of adolescent risk-taking, riding with a drunk driver versus a sober one. The analysis involves hypothetical options, option consequences, consequence desirability, and consequence probability. Option 1 is "Ride with John, who is very popular and very drunk." Option 2 is "Ride with Susan, who is very unpopular and sober." Possible consequences of riding with John are *(a)* to be badly injured in a car accident (desirability = -10, probability = .2) and *(b)* to have peers think you are square (desirability = -5, probability = 0.0). The desirability of these consequences when riding with Susan are the same, but their probability is different (injured in accident = 0.01; peers think square = 0.8). Given these values, the decision probability for an adolescent would be John = $(.2) \times (-10) = 2$ versus Susan = $(.01) \times (-10) + (.8) \times (-5) = -4.1$. This treatment is a laudable effort to apply cognitive models in developmental psychology; it examines options and consequences, rather than grasping at labels, such as claiming adolescents have a "taste for risk" or think they are "invulnerable." The authors also reveal the limitations of decision analysis, however, in showing that an expected utility approach to deciding what is a good choice is hard to use in this case, since the maximum subjective utility is higher for riding with a drunk driver than it is for riding with a sober one. The authors lament the dearth of information on how people evaluate their options and consequences when making a choice. Traditional models do not explain well-known risk-taking patterns, such as the predominance of substance use or physical risk-taking in youth, particularly young men (Gardner and Herman 1991).

Decision-field theory accounts for many empirical results of choice preference experiments with humans, such as the effect of time pressure on decision accuracy (Busemeyer and Townsend 1993). Based on analyses of approach/avoidance motivations and cognitive processing of choices, the model includes parameters for the variance in expected gains and losses for each choice. Developed in laboratory experiments with monetary choices, decision-field theory has not to our knowledge been applied to individual differences in risk-taking decisions, and it

would appear difficult to apply to the types of nonmonetary risks considered here. Individual differences could be proposed for the relevant parameters in the model (i.e., average preference for one of two choices), but that would not advance our understanding of risk-taking at this point.

The role of personality and/or temperament in risk-taking is well accepted (and is reviewed in Bromiley and Curley 1992). The personality that takes risks is variously described as impulsive, sensation-seeking, or suffering from behavioral undercontrol. Impulsivity has been defined as a tendency to engage in spur-of-the moment behaviors that reflect a loss of control (Plutchik and van Praag 1989). In their review, Plutchik and van Praag (1994) conclude that there is a genetic component to impulsivity. Impulsivity is related to violence (Apter et al. 1993) and is a feature of antisocial personality disorder (American Psychiatric Association 1994). Sensation-seeking, according to Zuckerman (1980, 1994), is a trait with a genetic component and biological correlates. There is wide agreement, however, that behavioral mechanisms or personality traits are not inherited, per se. Rather, response patterns develop over time through a complex interaction between a maturing person and the environment, where expression of a tendency is dependent upon individual experience as well as any biological vulnerability that may arise from effects of genetic variation.

More thorough models include the life course as a factor in risk-taking decisions. Gardner (Gardner 1993; Gardner and Herman 1991) has used this approach to analyze adolescent risk-taking, focusing on AIDS exposure. A risk taken during adolescence is compared with the same risk taken at a later point in life. This model for predicting risk-taking includes the relative benefits from the risk to participants versus nonparticipants at both time points, survival to a later point, income (which is assumed to increase linearly over the lifespan), and degree of discounting of future outcomes. Discounting is considered the primary factor behind adolescent risk-taking: "Discounting the value of the future when young may . . . simply be a rational response to uncertainty about the future. . . . Forgoing the consumption of a dangerous good is, from the expected utility perspective, an investment. You are buying increased life expectancy . . . and paying for it with *[forgoing]* present consumption" (1993:79). The weak factor in this model is the rationale for high adolescent discounting of the future value that would be available to non-riskers, which is attributed to adolescents' being worse at predicting future outcomes because of their relative ignorance and inexperience. Thus, Gardner and Herman (1991; Gardner 1993) added a lifespan perspective to the analysis of risk-taking. However, other aspects of biological models, such as mortality patterns and environmental

characteristics, can also be useful additions to the conceptualization and measurement of individual differences in risk-taking. A full integration of life history concepts into the analysis of human risk-taking could build upon Wilson and Daly's (1985) research on risk-taking variation by age and sex and Rogers's (1994) analysis of the evolution of time preference.

For example, a life history perspective clarifies the forces that might result in sex differences in risk-taking. As mentioned above, some patterns of expenditure are better than others in their effect on survival and reproduction. Further, in most species, it pays individuals to specialize in either mating or parental effort—the behaviors that make one successful in mating are often mutually exclusive of the behaviors that promote parental success (reviewed in Low 1993, 1994; also Daly and Wilson 1983). In life history theory, sex differences result from tradeoffs. In most species, mating specialists are likely to be male, and parental specialists are likely to be female. This specialization has profound and not immediately obvious implications. If one sex specializes in getting mates, and the other in investing in offspring, the two sexes are likely to behave quite differently, for mating and parental effort show very different reproductive "return curves" (reproductive success gained per unit of resources or status acquired, or effort spent; see Low 1993). Mating effort has a very high fixed cost; typically, a male must establish himself as successful (e.g., by growing antlers, fighting for dominance or a territory) before he can get even his first mate. Parental effort shows a more linear return curve; each additional offspring is likely to cost about as much as the first (Frank 1990).

In polygynous species, including humans, this dichotomy creates a strong bias; far fewer males than females actually reproduce, but the most successful male typically has more offspring than the most reproductively successful female. Great expenditure and risk may be profitable for males, so risky behavior and conflict are most often male endeavors. Physical intrasexual conflicts, which are more common among males, are more likely to escalate to lethal levels than other sorts of conflicts. Human male reproductive variance typically exceeds female variance, as in other mammals, resulting in striking sex differences in aggressiveness, sexual behavior, and risk-taking (e.g., Boone 1986, 1988; Daly and Wilson 1983, 1984, 1985a, 1985b, 1987, 1988; Low 1988, 1990, 1993; Low and Clarke 1992; Smith and Boyd 1990). This difference, of course, is what prompted Darwin (1871) to treat sexual selection differently from ordinary natural selection. Darwin was perplexed that males often seemed to do expensive and risky things that got them killed. The secret was that when the mating stakes are high, and success is rare,

expensive and risky behavior can be profitable. Although this tends to be true for mating effort, it is not usually true for parental effort.

Similarly, age differences in risk-taking patterns can be illuminated by including a life history perspective. Rogers's analysis of the evolution of time preference (1994) presents an age-specific utility function. This model bases utility on the expected value of consumption either to oneself or to one's future descendants, determined by the relative reproductive values of the recipients. Benefit is formally defined as age-specific reduction in mortality (to be used for survival), which differs from the usual definition of time preference (diminishing marginal utility of consumption at a given time, discounting of future vs. present utility). Two causes of discounting were used, risk of death and desire to provision descendants. The model predicts discounting to be high during the teens and young adult years, then to decay, then to rise again in later life. The pattern resembles the empirical distribution of average risk-taking. A life history perspective may also help illuminate *individual differences* in time preferences or discounting, which is a required extension for an adequate model of risk-taking.

RISK-TAKING VIEWED IN THE CONTEXT OF LIFE HISTORY STRATEGIES

As mentioned above, the allocation pattern that is most effective in a particular case depends on many factors, such as environmental resources (amount and predictability), mortality rate (juvenile and adult), and return from investment (shape of return curve) (Roff 1992; Stearns 1992). These factors may also underlay individual differences in time preference or discount rate by affecting the optimal life history. They affect whether the best strategy is to take an early risk rather than conserve resources. We will use "benefit" generally, although a complete evolutionary analysis would use benefit in the currency of eventual reproductive success.

Current vs. Future Conditions

A central life history problem is the tradeoff between current reproduction and future reproduction. A consideration of current versus future conditions has informed previous work (Hill and Low 1992; Hill et al. 1994). On the one hand, in stable or increasing populations, offspring produced *now* mature earlier than future offspring and thus have higher reproductive value (Fisher 1958:27–28). On the other hand, high current reproductive effort carries costs: reduced chances of survival and low-

ered future reproduction (e.g., Lessells 1991; Roff 1992:172 et seq.; Stearns 1992:84). Thus, one's own survivorship is traded against the value of one's offspring. In some situations, it is not advantageous to save resources for future use or invest them in one's own further growth and development (Rubenstein 1982). When the environment is unpredictable, one's future chances for reproducing are also unpredictable; the best strategy may be to reproduce when sufficient resources first become available (cf. Dickemann 1986; Hill and Low 1992; Rubenstein 1982). When resources are scarce but predictable, and mortality rates are low, the best strategy must be to save resources until a threshold level is reached, and defer reproduction (as argued in Maccoby 1991). When resources are unpredictable, however, there is less potential benefit from delay.

This paper will discuss several areas where a life history perspective guides us to examine parameters that traditional models would not. When examining the choice of taking a risk versus avoiding it, two predictors stand out that relate to the costs and benefits: survival expectations and expected variability in future environment (and the predictability of return from one's efforts). Avoiding a risk can be construed as preserving survival. These two factors will be discussed further.

Subjective Expectations about Survival Probability

Compared with other primates, humans delay maturation considerably, but there is variation both across and within populations. As noted above, age-specific mortality influences timing of reproduction; in risky environments, current reproduction is heavily favored over delayed reproduction. When adults suffer a high mortality rate, opportunistic breeding when young may be the most successful strategy (Dickemann 1986). In humans, *social* perception of these factors might be important (e.g., Lancaster 1994). For example, Geronimus (1987, 1996) has argued that most teenage mothers in the United States today are members of an urban economic underclass (which suffers higher age-specific mortality and poorer health than many other groups), who may well be optimizing their fertility schedules in a life history context (see also Dryfoos 1991). Bereczkei (1993) reported that Hungarian Gypsies, with higher mortality rates than non-Gypsy Hungarians, also had higher fertility rates and began having children at younger ages. A pattern seen commonly in poor neighborhoods is early childbearing with grandmaternal care of children; Burton (1990) interpreted this pattern to be a functional response to low survival rates in an environment where a two-parent

nuclear family mode is not feasible. Most of the women in her study sample (91%) expected their lifespans to be 60 years (Burton 1990:132).

A conceptual model of the relationship between local mortality rate, attachment style, and short- versus long-term mating strategies has been presented by Chisholm (1993, n.d.). He elaborates on the role of mortality rate, using Promislow and Harvey's (1990, 1991) proposals that life history traits are affected by the intensity and age-specificity of mortality rates. In a study with female college students (Chisholm n.d.), he measured expected mortality by asking subjects to guess how long they thought their lives would be (mean = 81.46 years). Orientation toward the future was assessed using a standardized scale (the Zimbardo Time Perspective Inventory; Zimbardo 1990). These measures correlated as expected with age at onset of sexual behavior and rate of taking new partners. This finding supports the proposal that perceptions of the future relate to sexual behavior, and probably to risk-taking in general.

Only one other study has queried people about specific lifespan estimates, to our knowledge (DuRant et al. 1994). In this study of adolescents from neighborhoods with high rates of violent crimes, social and psychological factors were measured to determine their association with use of violence. Also included was a measure of respondents' confidence of being alive at age 25. The item has a five-point response scale, anchored by "I am absolutely sure that I will live to be 25 years of age" to "I am absolutely sure that I won't live to be 25 years of age" (DuRant et al. 1994:614). Responses to this item had a low but significant correlation with current use of violence ($r = .18$), but no relationship to previous exposure to violence ($r = -.11$). A recent study of demographic and mortality data for 77 community areas of Chicago found a correlation of $-.88$ between average life expectancy (ranging from 54.3 to 77.4 years) and the neighborhood homicide rate (Wilson and Daly 1997). Further, the community areas with the shortest average life expectancy also showed higher birth rates for young age groups of women, relative to areas with the longest life expectancies.

Environmental Resource Unpredictability

Life-course patterns can vary from a truncated life course, with shorter lifespan and early age at maturation and reproduction, to an extended one, with delayed maturation, by varying the timing of allocation to one's own growth versus offspring growth (cf. Borgerhoff Mulder 1992; Hill and Low 1992). Evolutionary-oriented anthropologists and psychologists have hypothesized that distinctive life history patterns exist in humans (Belsky et al. 1991; Dickemann 1986; Draper and Belsky 1990;

Draper and Harpending 1982; Lancaster and Lancaster 1987). In particular, a strategy consisting of early reproduction and transient child-rearing relationships has been proposed (Belsky et al. 1991; Draper and Belsky 1990). These arguments are consistent with the work of Surbey (1990), which documented early menarche by young women from homes with absent fathers. In interviews with forty young adults, Hill, Young, and Nord (1994) found that adult attachment security was associated with the magnitude and predictability of parental investment during childhood, which was classified as lower in cases with a short interval between siblings, parental divorce, fewer economic resources, or less nurturing parents. Results were consistent with an association of unpredictable early environments, insecure attachment style, and short-term mating strategies. The non-securely-attached subjects were less likely to have attained enduring marriages; those who had married or cohabited began these relationships at a younger age and after a shorter courtship period and were more likely to be divorced or separated, relative to securely attached subjects who were married or cohabiting.

Along with attachment, other aspects of cognition and behavior may be similarly affected by early environmental unpredictability, as would be predicted from evolutionary theory. To the extent that cognition, like other traits, is subject to natural selection, the functional organization of the human mind, such as the features of mental models, is likely to have evolved in response to selective forces related to environmental conditions. One would predict prepared or selective learning (Garcia et al. 1974) of certain environmental dimensions, such as resource availability and distribution.

Humans may indeed develop a mental model of environmental predictability (Chisholm 1996; Ross and Hill n.d.a). Individuals who grow up in a family and/or neighborhood permeated with unpredictability are likely to develop the belief that the world is basically an unpredictable place. This is especially likely if unpredictable events were highly salient (Fiske and Taylor 1991), such as the sudden death of a parent, or continuous, such as witnessing ongoing crime in the neighborhood or living with an alcoholic parent. How we view our environment—and the actions and interactions that take place in it—is affected by our mental models of how the world operates. Ross and Hill (n.d.a) label this mental model an unpredictability schema. Schemas are defined as working models or cognitive structures that store and organize information and experiences about the world (Mandler 1985). This unpredictability-schema construct would subsume a variety of existing psychological dimensions that show individual differences, such as self-efficacy, locus of control, and causal uncertainty. Ross and Hill (n.d.a) review the antecedents, correlates, and consequences of having an unpredictability

schema. Whereas much research in psychology and sociology has focused on the *amount* of social and economic resources, our model considers the *predictability* (i.e., stability) of resources as more important for understanding risk-taking. For the research described in this report, we use a preliminary measure of such a schema, referred to here as unpredictability beliefs.

It is reasonable to expect that ongoing unpredictability beliefs are associated with risk-taking, because perceptions of environmental unpredictability are associated with planning for the future. We propose that the "here and now" is more salient for persons with chronic unpredictability beliefs, who tend to focus on current costs and benefits of their behavior rather than on future costs and benefits. In contrast, individuals who believe that life is predictable are able to foresee a future, so the salience of future costs and benefits of their behavior is increased while the costs and benefits of immediate gratification become less important. Therefore, we predict that persons with ongoing unpredictability beliefs would be more willing to engage in risky behaviors that involve current benefits as well as potential future costs.

In summary, risk-taking may be related to a cognitive unpredictability schema, which develops in a highly unpredictable early environment (Ross and Hill n.d.a). Here we examine the relationship of risk-taking to two specific aspects of expectations about one's future—confidence of a long and healthy lifespan and beliefs about future unpredictability. This preliminary study is based on a survey conducted with community college students. It is intended primarily as a guide for future research, as an example of how the relevant constructs can be measured and analyzed. Figure 1 depicts the conceptual model that guided the analyses.

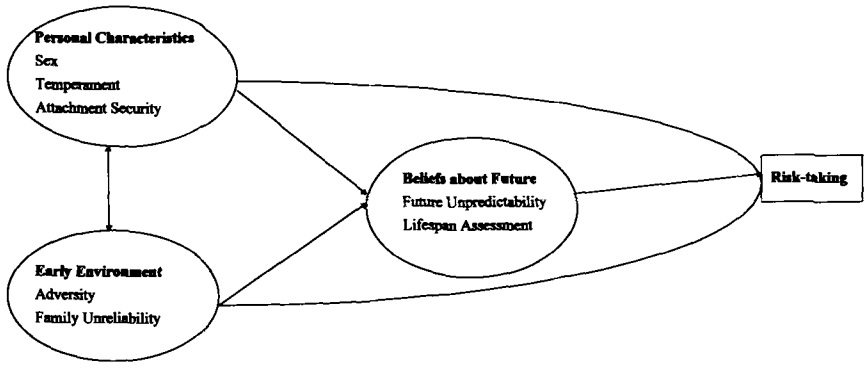

Figure 1. Conceptual model of individual differences in risk-taking.

Of primary interest was the role of lifespan estimate and future unpredictability in variation in risk-taking behavior. These two measures were used as predictors of risk-taking. This model also includes risk appraisal, because it is well known that perception of the risk of an act is related to performing it (Yates and Stone 1992). Personal characteristics that relate to risk-taking were included in the model in order to determine whether beliefs have an influence over and above well-known predictors of risk-taking (i.e., sex, temperament, attachment, early environment).

METHODS

Participants

Self-report questionnaires were completed by community college students (n = 107) and their acquaintances (n = 52) (total = 159, 58 men and 101 women). Most subjects were in their early twenties (mean = 23.5 ± 7.4). While most were Caucasian (82.6%), there were a number of African American participants (11.8%), along with students from other ethnic groups (5.6%). As would be expected with a younger, predominantly single sample recruited from a college setting, most participants had a limited annual personal income (36.6% less than $4,999 per year; 55.3%, $5,000–19,999; 6.2%, $20,000–49,999; and only 1.9%, $50,000 or more). Participants' estimates of household income were much higher (21.0% below $19,999 per year; 31.8%, $20,000– 49,999; 47.2%, $50,000 or more). Few participants were already married (18.2%) or had children (23.3%).

Procedure

Instructors from four community colleges in southeastern Michigan were contacted, and ten instructors granted permission for the second author (LTR) to attend class and read a brief introduction to the study. During the presentation, students were told that participation was voluntary and confidential, and that if they were interested they could take home and fill out a survey, which was expected to take about 45–60 minutes. Students were told that they would be mailed a $10 check for their participation. Students were also asked for help in recruiting another person, preferably friends of a similar age who had never been to college. They were read a script explaining that these individuals must be at least 18 years old, and that they too would be paid $10 for participating. This procedure was used to diversify the sample. Survey packets were distributed to interested individuals, containing a consent form and a questionnaire including multiple standardized scales. The project

was cleared with the University of Michigan Medical School Institutional Review Board, and, where applicable, with the community colleges' ethics committees.

Measures

Risk-taking. Risk-taking was broadly conceived to include risks in the areas of safety, health, sexual behavior, finances, and social relationships. The risk-taking behavior scale included smoking (never, past history, and current), risky drinking (as defined in Hilton and Clark 1987) (number of days in past month of drinking five or more drinks, analyzed as 0, 1, 2, 3, 4, 5, and 6 or greater), gambling, and fifteen items with the stem phrase of "How often do you . . . ?" Other behaviors included social risks (e.g., borrow money from people and not repay, fight or argue with strangers, fight or argue with boss or teachers, falsely call in sick, turn down requests for help, fail to keep promises, gamble), safety risks (e.g., not wearing a seat belt, riding a motorcycle, driving under the influence, acceptance of a risky job), health risks (e.g., eating foods that are high in fat, failing to exercise), and sexual risks (e.g., not using birth control, having "unsafe sex"). The internal consistency of the risk-taking scale was acceptable (Cronbach's $\alpha = 0.73$). The risk-appraisal scale used the same items but queried, "How risky do you think it would be to . . . ?" Response codes ranged from 1 (not risky at all) to 4 (very risky). Acceptable internal consistency was obtained for the full scale ($\alpha = 0.78$). Total risk-taking and risk-appraisal scores were moderately interrelated ($r = -.36$, $p = .0001$).

Personal characteristics. Sex and temperament, well-known predictors of risk-taking, were included, as was attachment security. Risk-taking temperament was measured using the sensation-seeking scale (Zuckerman 1979), which indicates the propensity to try new experiences and avoid people and things that are dull or predictable (the higher the score, the higher the level of sensation-seeking). Calculation of the twenty-item version of Zuckerman's (1979) scale reflects high ($\alpha = .76$) sensation-seeking levels. In addition, a single forced-choice adult attachment item was included, asking respondents to characterize themselves in one of three relationship patterns (Hazen and Shaver 1987, 1990). In previous work (Hill et al. 1994), this item had 90% concordance with a classification derived from the full subscales. Ambivalent and avoidant styles were collapsed for analysis into an insecure attachment category, as in previous work (Hill et al. 1994).

Early environment. Two aspects of early environment were measured, adversity and family unreliability. *Adversity* was analyzed as the total

of three items—neighborhood crime, family poverty, and parental absence—with higher scores indicating a more stressful environment. Participants were asked to think of the house they lived in the longest from age 6 to 13 and indicate the level of crime in their neighborhood (age range was chosen to be congruent with that used in other relevant adversity studies, i.e., Kurtz and Derevensky 1993, Robins et al. 1985). Scores ranging from 0 (very safe, very low crime) to 5 (very unsafe, high crime) were reversed for the environment scale. A poverty item asked participants to estimate whether their family was well-to-do (1), average (2) or poor (3) in comparison with other families. Parental absence was scored as the number of absent parents (0, 1, or 2), based upon participant report about whether or not they lived with their mother or their father during the ages of 6 to 13. Although these items are not unidimensional and do not form an internally consistent scale ($\alpha = .30$), the sum was included nevertheless as a general marker of the quality of early environment.

Another measure of early environment *(Family Unreliability)* was included because our previous work has indicated its important relationship to risk-taking and the development of a mental model of the future as unpredictable (Ross and Hill n.d.a, n.d.b, in press). The Family Unreliability scale included ten items (generated by the investigators) measuring the frequency and consistency of planned activities in the family and four items measuring parental predictability (from the Home Environment Interview; Robins et al. 1985). Participants were asked how frequently (from never to very often) their immediate family got together for birthdays and holidays, for family activities or outings, for trips or vacations, and for the evening meal. Similarly, participants were asked how consistently (from never to very often) initial plans for these activities were actually carried through. Parental predictability questions pertained to dependability (keeping promises, carrying out threats that were made) and consistency (regarding rules). Each of these yes/no items was asked separately for mother and father, then summed. Scores on these fourteen items were added for the Family Unreliability scale, which was internally consistent ($\alpha = 0.77$).

Beliefs about the unpredictability of the future. A gross measure of *Future Unpredictability Beliefs* was constructed by combining total scores from four scales: (1) causal uncertainty, (2) self-efficacy, (3) locus of control, and (4) three items generated specifically to reflect unpredictability beliefs, such that higher scores reflect a greater degree of uncertainty about the stability and manageability of the future. The total score had marginal internal consistency ($\alpha = .62$), but it was retained as a composite, rather than using the four scales individually. Eight items from Weary

and Edwards's (1994) Causal Uncertainty Scale were used to measure beliefs about whether or not good and bad events that happen to oneself and others are due to predictable reasons. Eight items from Sherer et al. (1982) were included to measure general self-efficacy, or the extent to which people believe they can control and influence outcomes in their lives. Eleven items from Rotter (1966) were included. Items were scored such that higher values indicate a more external locus of control, or believing that outside and uncontrollable forces such as other people or luck determine one's destiny. Three items generated by the investigators were included to measure general beliefs about unpredictability: "Basically, I have a good idea about what is going to happen in my life," "Basically, I know what to expect from people in my life," and "Basically, the world is a predictable place."

The *Future Lifespan Assessment* measure was created by the investigators for this study; it included four items with the stem question, "How likely is it that you will [. . .] at these ages?" The items were "be alive," "remain healthy," "be financially secure," and "be happily married." The instructions read, "For this section, we want you to guess about certain events in your future. We want to know how likely you think each event will be during each decade of your life. Please write in each blank the likelihood that you will have a certain event occurring at each decade." After each item, eight age categories were listed (20–29, 30–39, 40–49, 50–59, 60–69, 70–79, 80–89, 90+), with blanks below them to write the estimated likelihood from 0 (extremely unlikely) to 10 (extremely likely). Two examples were given before the questions. Measures can be extracted from this assessment in various ways. Because this is a new measure, details will be presented in the Results section.

Statistical Analysis

Descriptive analyses used Pearson and Spearman correlations (depending upon variable distributions) and *t*-tests (e.g., comparing men with women, and secure attachment with nonsecure attachment). For all analyses, the following significance levels were used: $p < .01$, highly significant; $p < .05$, significant; $p < .10$, statistical trend; $p > .10$, not significant. The internal consistency of summary scales was measured using Cronbach's alpha (with standardized variables). Hypothesis-testing analyses followed the conceptual model presented previously (Figure 1). Hierarchical multiple linear regression models were developed to predict risk-taking. Variables were entered into the model sequentially in three blocks (personal characteristics, early environment, and future beliefs). This order was selected for two purposes. First, it reflects our conception that personal factors (sex, temperament, adult

attachment security) and early environment (adversity, family unreliability) antecede beliefs about future predictability and one's lifespan. Second, it allows us to test whether future unpredictability beliefs and lifespan assessment factors significantly predict risk-taking after accounting for the variance owing to traditional predictors. Significant factors from the previous block were retained when entering the next block.

Two other regressions were conducted. In one, interactions involving sex were added to the regression models because of previous research indicating the theoretical and empirical role of sex in risk-taking. However, the prediction of risk-taking was not enhanced by adding interactions with sex to the model, beyond the main effect used before. No interactions reached significance as independent predictors. Because this analysis indicated no sex interactions, results will not be presented. In the other secondary analysis, risk appraisal score was entered as the last variable in the final model. Of interest was whether lifespan and future beliefs acted through making risks seem less risky, or whether indeed people were taking risks that they recognized as risky. Finally, because of the unusual nature of the sample, analyses were run twice. First, students and acquaintances were pooled. Then, analyses were rerun using only the student sample recruited by class presentations. This procedure evaluated the robustness of findings; different predictive models were not expected. The samples were similar in the characteristics of interest (univariate tests between sources showed no significant differences on age, sex, risk-taking, risk appraisal, adverse environment, or personal characteristics averages). The majority of the results that follow are thus based on the pooled sample.

RESULTS

Future Lifespan Assessment

Of great interest in this study were the respondent's beliefs about mortality, or expectation of survival. Most respondents were confident of survival to age 40 (85% rated expectation = 10), and most expected not to survive to age 90 (44% rated expectation = 0). Assessments for adjacent decades were highly correlated (r_s from .71 to .84), whereas correlations were much lower for ages more than two decades apart. Maximal variance among ratings was shown for decades 70 and 80. A scale could be created using the four types of items for these two decades, with adequate internal consistency. However, the items other than survival were not tightly correlated. For age 80, for example, health

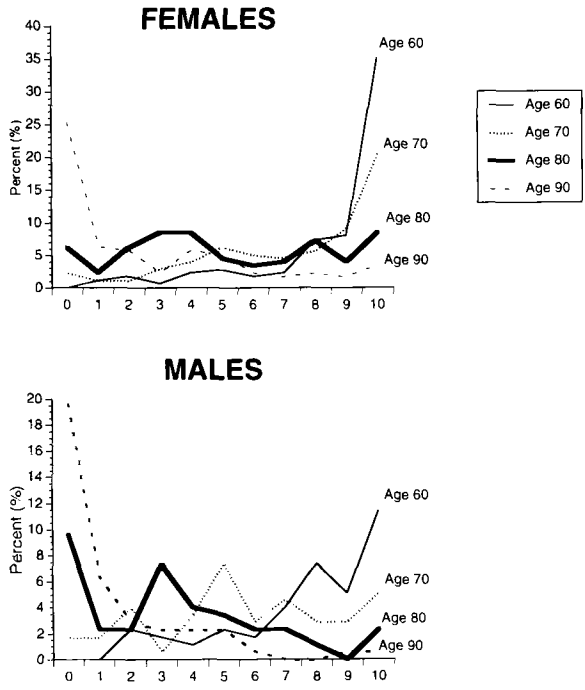

Figure 2. Degree of confidence in living to each decade for men and women (Future Lifespan Assessment). Percent of sample who chose each confidence rating (0–10) is shown.

confidence correlated more highly with financial security (r_s = .47) than with marital happiness (r_s = .26), although expectation of being happily married correlated well with expectation of financial security (r_s = .43) (all $p < .01$). Ratings for financial security and being happily married were somewhat contradictory for a good number of subjects, so further analyses concentrated on ratings of survival probability, which are of greatest theoretical relevance in the present study. Figure 2 shows the percentage of men and women who endorsed each lifespan expectation rank (0–10) for four decades (60, 70, 80, and 90). Men and women differed in their confidence of having a long and healthy life. A majority of men were not confident of living to age 70 (41.5% gave confidence ratings of 7–10, compared with 63.6% of the women), and did not expect to live to age 80 (58.5% gave confidence ratings of 0–3, compared with 36.6% of the women). For further analyses, a survival expectation for ages 70 and 80 were combined, forming a normally distributed and internally consistent scale (α = .88), referred to here as the Future Lifespan Assessment.

Table 1. Means (± s.d.) or Percentages for Scale Scores and Specific Risk-Taking Measures: Univariate Tests for Sex and Adult Attachment Security

	Men		*Women*			
	Secure $n = 30$	*Nonsecure* $n = 28$	*Secure* $n = 42$	*Nonsecure* $n = 59$	*Sex* p	*Attachment* p
Temperament	29.0 (4.2)	29.8 (3.4)	27.4 (3.9)	27.5 (3.4)	<.01	n.s.
Adversity	3.9 (1.2)	4.1 (1.4)	3.7 (1.0)	4.2 (1.3)	n.s.	<.05
Family unreliability	15.1 (4.1)	16.4 (3.4)	14.2 (5.1)	17.8 (6.0)	n.s.	<.01
Lifespan assessment	10.0 (6.0)	7.9 (4.2)	12.6 (6.0)	12.0 (5.6)	<.01	n.s.
Future unpredictability beliefs	82.7 (17.3)	101.5 (14.2)	91.4 (17.4)	98.2 (18.6)	n.s.	<.01
Risk appraisal	48.8 (6.0)	48.1 (6.7)	52.4 (6.1)	50.3 (8.2)	<.05	n.s.
Risk-taking total	41.9 (9.4)	43.2 (10.1)	37.6 (9.3)	39.2 (7.4)	<.01	n.s.

Univariate Relationships

Relationships among measures were assessed preliminarily using univariate tests (correlations and *t*-tests). Descriptive statistics are given in Table 1, which compares men and women and securely versus insecurely attached groups. Risk-taking was more frequent for men than for women, but it did not vary by attachment security. In addition, men reported lower risk appraisals, less expectation of survival to ages 70 and 80, and more sensation seeking, compared with women. Adult attachment security did not influence risk appraisals, lifespan assessment, or risk-taking. However, securely attached individuals reported less childhood adversity, less family unreliability, and weaker future unpredictability beliefs than did less securely attached individuals.

Table 2 shows the intercorrelations among other measures (continuous measures). Risk-taking correlated significantly with the proposed antecedents, except for the relationship with childhood adversity, which was only a trend. The most interrelated predictor variables were adversity with family unreliability, risk appraisal with temperament and lifespan assessment, and family unreliability with future unpredictability beliefs.

Most participants had not yet married or had children. Nine men and 29 women had children, on average having the first child when they were in their early twenties (mean = 24.4 for men, range 18–31; 21.7 for

Table 2. Interrelationships among Risk-Taking, Antecedents, and Beliefs: Spearman Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Temperament	1.00	−0.065	−0.037	−0.106	−0.016	−0.308	0.280
	—	ns	ns	ns	ns	**	**
(2) Adversity		1.000	0.227	−0.046	0.142	−0.073	0.152
		—	**	ns	+	ns	+
(3) Family unreliabilility			1.000	−0.071	0.225	−0.153	0.217
			—	ns	**	+	**
(4) Lifespan assessment				1.000	−0.170	0.215	−0.218
				—	*	**	**
(5) Future unpredictability					1.000	−0.183	0.190
					—	*	*
(6) Risk appraisal						1.000	−0.370
						—	**
(7) Risk-taking							1.000
							—

ns = $p > .10$
\+ = $.10 > p > .05$
* = $p < .05$
** = $p < .01$

women, range 15–30). The small sample precluded extensive analysis of early reproductive behavior; nevertheless, to inform future research, we compared these subjects with those without children on the primary measures of future beliefs. Although these results did not achieve statistical significance, three sets of relationships are in the expected direction. First, men with children, relative to those with none, appeared to be more frequent risk-takers (45.1 vs. 41.9), expected a briefer life (6.8 vs. 9.5), and expected more future unpredictability (98.8 vs. 90.3). Second, although women with children were similar to those with none on risk-taking and lifespan assessment, women with children appeared to be lower in future unpredictability beliefs. Third, testing for correlations of age at first birth for women ($n = 29$) indicated no relationship with lifespan assessment ($r_s = .00$); however, age at first birth did appear to be related to risk-taking ($r_s = -.23$, n.s.) and unpredictability beliefs ($r_s = -.33$, $p < .10$). In a larger sample, these three sets of possible relationships might have reached significance. They are reported here only as suggestive evidence that may guide future research.

Because sexual and reproductive risk-taking was of special interest, secondary analyses focused on the two relevant questions (not using birth control and having unsafe sex). Those who were sexually active (69.8%) rarely endorsed these items. Many subjects claimed they "never" or "rarely" failed to use birth control (71.0%) or had unsafe sex

(73.5%). These items were associated with the primary antecedents. Failing to use birth control was associated with attachment security (mean frequency, secure = 1.6; insecure = 2.4; attachment, $p < .05$; sex, n.s.) and adversity ($r_s = .16$, $p < .10$). The frequency of having unsafe sex varied by sex but not attachment security (mean frequency, men = 1.8; women = 2.3; attachment, n.s.; sex, $p < .10$). This item significantly correlated with the antecedents of adversity ($r_s = .20$, $p < .05$) and family unreliability ($r_s = .21$, $p < .05$).

Predictors of Risk-Taking

Multiple linear regression models were developed to predict risk-taking, according to the conceptual model presented previously (Figure 1). Variables were thus entered into the models hierarchically, in the order of personal characteristics (sex, temperament, and attachment), childhood environment (adversity, family unreliability), and beliefs (lifespan assessment and future unpredictability beliefs). Significant predictors from the preceding block were retained when entering the next block. Results are shown in Table 3. Personal characteristics predicted 12.6% of the variance in risk-taking (F [3, 153] = 7.32, $p < .01$). Attachment was not independently significant and was dropped from subsequent models. When the two early environment measures were entered (adversity and family unreliability), only family unreliability was significant and retained. The model with sex, temperament, and family unreliability was improved ($R^2 = .195$, F [4, 154] = 9.32). Future lifespan assessment and future unpredictability beliefs were entered in the next block; they improved the model further (F [5, 153] = 9.69, $p < .01$; $R^2 = .241$). Unpredictability beliefs was independently significant ($p < .01$) and subsumed variance previously attributed to lifespan, which lost significance in the simultaneous model. The final model, shown in Table 3, accounted for 24% of variance in risk-taking. Unpredictability beliefs

Table 3. Final Predictive Model of Risk-Taking

	Sequential Model			*Simultaneous Model*			
Source	*partial* R^2	F	p	*parameter*	t	p	*s.e.*
Intercept				13.19	1.94	<0.10	6.79
Sex	0.044	8.84	<0.01	−2.68	−1.91	<0.10	1.40
Temperament	0.072	14.41	<0.01	0.64	3.71	<0.01	0.17
Family unreliability	0.074	14.79	<0.01	0.37	3.01	<0.01	0.12
Future unpredictability beliefs	0.024	8.36	<0.01	0.10	2.89	<0.01	0.11

Model $R^2 = .2306$
F [4, 154] = 11.542; $p < 0.01$

significantly contributed to variation in risk-taking, after accounting for the traditional predictors of sex and sensation-seeking temperament.

The relationship among future unpredictability beliefs and risk appraisal was further investigated. In a secondary regression analysis, risk-appraisal total was included in the best previous model (Table 3). Risk appraisal improved the model slightly (R^2 = 26%) and was independently significant. It did not affect the significance of unpredictability beliefs ($p < .01$). The future unpredictability measure thus did not appear to be related to judgments of the danger involved in the specified risky behaviors.

Because of the unusual nature of the sample, several analyses were conducted, again using only the original subjects—students contacted in class. Univariate correlations of risk-taking with antecedents were of similar magnitude and direction to correlations using the full sample, but power to show the effects was lower. The final regression model, which included temperament, family unreliability, and lifespan assessment, accounted for a similar proportion of variance as in the full sample (F [3, 103] = 9.80, $p < .01$; R^2 = .222). In the sequential analysis, sex, adversity ability, and unpredictability beliefs did not reach significance whereas lifespan assessment tended to remain predictive ($p < .10$) after temperament and family unreliability were entered. However, lifespan assessment lost statistical significance in the simultaneous model after unpredictability beliefs were also entered, even though unpredictability beliefs were not independently significant.

DISCUSSION

Risk-taking was related at the univariate level to personal characteristics, environmental adversity, and future beliefs. In multivariate models, the best independent predictors of risk-taking were temperament, family unreliability, and unpredictability beliefs. Lifespan assessment lost its univariate significance in the multivariate model, because it covaried with unpredictability beliefs. Together, the final predictors accounted for 24% of the variance in risk-taking. This series of models used a very conservative test for the role of lifespan assessment and schema, because they were entered only after accounting for sex and sensation-seeking, predictors with strong, well-known effects on risk-taking (Wilson and Daly 1985; Zuckerman 1980). As a new measure, the Future Lifespan Assessment usefully captured individual differences in confidence of a long life. It had univariate relationships with sex, risk-taking, risk appraisal, and unpredictability beliefs.

Men's average risk-taking total was higher than women's. As described in the introduction, the payoff from risky behavior will be higher for those who have more variance in reproduction (i.e., men), whose possible return may be higher, relative to those with greater possible cost or less benefit. If potential costs and benefits (in terms of return from investment) are unusual in specific ways, we might expect increased risk-taking among women and increased parental investment among men. Young women may show higher rates of physical conflicts with other young women, when potential partners are scarce (i.e., "resource rich young men"; Campbell 1995:99) and intrasexual competition for them increases (Campbell 1995), whereas parental investment by males will be higher in ecological or economic situations where the return from investment is higher (Hill and Hill 1990). Thus, the currency of costs and benefits is more general and widely applicable than using categorical explanations such as sex without regard to context.

Temperament also had a strong effect on risk-taking, as expected from previous literature. Given the commonality between sensation-seeking and risk-taking and their significant moderate correlation, it is important that the two "future expectation" measures were able to improve prediction. Thus, sensation-seeking and future expectations appear to predict different aspects of risk-taking. Note that sensation-seeking was not significantly correlated with lifespan assessment or future unpredictability beliefs, in spite of the inclusion in the sensation-seeking scale of two items that refer to a dislike for predictable friends and movies (part of the boredom-susceptibility subscale; Zuckerman 1971). Sensation-seeking items are in the form of preferences, rather than behaviors. Expressing a desire for an experience is thus separable from performing an act. An individual with a sensation-seeking temperament may be more vulnerable to risky acts, however, because the immediate benefits are more highly valued. The interaction of temperament with environment during development requires further study.

Results were generally congruent with the proposal that unpredictable early environments are related to the development of a view of the future as unpredictable and an expectation of short life, and that these beliefs related to risk-taking. Aspects of environmental unpredictability have also been linked to aggression (which is a type of risk-taking, since physical harm may be involved). Through a survey of southside Chicago elementary and high school students (aged 10 to 19), Bell and Jenkins (1993) found a link between students' perpetration of crime and their past experience with witnessing or being victims of crime; we consider crime victimization to be a marker of environmental unpredictability. Aspects of unpredictability in childhood such as family functioning and neighborhood dangers have been linked in other research to the psycho-

logical constructs believed to be subsumed in our measure of future unpredictability beliefs. For example, having divorced parents was detrimental to cognitive (but not physical) self-efficacy among six- to thirteen-year-old children (Kurtz and Derevensky 1993). Children in a lower socioeconomic group appear to have increased causal uncertainty (Butler 1986), less ability to delay gratification, and a weaker future-time perspective (Lomranz et al. 1983). Also, secure maternal attachment at 13 months predicted the ability of six-year-old boys to delay gratification (Olson et al. 1990).

The future unpredictability beliefs measure used in the present study includes self-efficacy, the expectation that one can control and influence outcomes, or confidence in one's competence (Sherer et al. 1982), and locus of control (LOC), the belief that the future is determined by one's own behaviors and efforts (internal LOC) or by outside and uncontrollable forces such as luck and other people (external LOC; Sherer et al. 1982). There are other measures that might better assess the construct. Three that deserve study are consideration of future consequences (Strathman et al. 1994), sense of coherence (Antonovsky 1987), and time preference (Zimbardo 1990). The Consideration of Future Consequences Scale (Strathman et al. 1994) measures the extent to which one evaluates future versus immediate consequences of one's actions. A total score is derived from the twelve-item unidimensional scale. Respondents rate how characteristic of themselves are statements such as "I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years" (1994:752). Sense of coherence has three components: comprehensibility, manageability, and meaningfulness. Comprehensibility is the extent to which information that one encounters is predictable, ordered, structured, and clear. Manageability is the extent to which one's resources appear adequate to meet demands. Meaningfulness reflects one's feelings that it is emotionally worthwhile to work on the challenges presented. The Zimbardo Time Preference Inventory (Zimbardo 1990) is a self-report scale measuring the extent of orientation to the future versus the present or past. There are four standard subscales, representing four orientations: future, present-hedonistic, present-fatalistic, and past. This scale has promise for differentiating individuals according to their focus on future versus present benefits and costs of their actions.

Although the questionnaire data presented here allow the testing of some predicted relationships, these data have clear limitations and are presented as a preliminary study to guide future research with life history concepts. The sample was not randomly selected from community dwellers, but restricted to community college students and their acquaintances. Generalizability is thus limited for persons of older ages

and less education, for example. The measures, while capturing the constructs of interest, also had weaknesses. The Future Unpredictability Beliefs measure is only marginally reliable; we used it in its present form knowing that the construct will be developed more fully later. The poorest measure was adversity, because the items were not internally consistent. In this usage, it is better seen as an index, a sum of vulnerability factors that are relatively independent, rather than a scale of interrelated items. Past research and theoretical importance indicated that we must include a measure of adversity. Another measure used as a regression predictor, the one-item, forced-choice attachment designation, was crude, yet it was related to family unreliability and unpredictability beliefs in the expected directions. The dependent measure of general risk-taking, a scale total, is related, but not identical, to reproductive risk-taking. Unfortunately, the sample was not ideal for studying reproductive decisions; few participants had children, and most were sexually active but denied sexual risk-taking. We failed to include any measure of pubertal timing, which is highly relevant to life history (see Surbey 1990) and was also important in Chisholm's (n.d.) analyses of sexual behavior described above. With a cross-sectional study, correlations can be detected, but causality is unclear. Longitudinal studies with community samples will be required to disentangle the interplay of belief formation and risk-taking behavior. Lastly, the processes described here operate at the level of the individual. It is clear that other macrolevel forces affect risk-taking and must be included for a full understanding.

Nevertheless, these results add to our understanding of risk-taking by illuminating possible sources of individual differences in the future discount rate. Thus, integrating a life history perspective may add several unique ideas to our models of risk-taking: an interpretation of behaviors as functioning to obtain social and economic resources; an analysis of costs/benefits relative to alternative reproductive behaviors, such as investing in kin; an analysis in terms of costs/benefits for behavior in the present versus the future, and an analysis of the environment using both amount and predictability of available resources. The innovative aspects of Gardner's lifespan rational choice model of risk-taking (1993) were his inclusion of parameters for subjective survival expectation and time preference. His model could be improved in the treatment of estimates for future outcomes to non-riskers. He presents a reasonable estimate of a youth's view of the value of future outcomes as related to a quantity he terms *ability* (which is akin to future resources). One could go further and propose that individuals observe variance in outcomes around them, leading to individual differences in estimates of variance. Environmentally based variance needs investigation to augment a model of individual differences in risk-taking.

The optimal life history is affected by survival patterns, the stability of environmental conditions, and the shape of the return curve for effort invested in offspring. Most optimizations (expected utility of risk-taking or life history decisions) employ some formulation of reproductive value (Fisher 1958), which is the cumulation into a future age x of the product of three quantities: the expected number of offspring one will produce at age x, the probability one will survive to age x, and the discount for worse conditions at age x (cf. Horn and Rubenstein 1984). We can also employ this formulation. Take an example where resources steadily accrue over a number of years (income increases linearly with age, as in Gardner 1993). Assume that the return curve from investment of any amount (i.e., expected number of offspring at age x) has a sigmoidal shape and units are discrete (e.g., offspring). The relationship between resources and reproductive output is assumed to be sigmoidal, because output will generally increase except initially, where some threshold of resources must be available before they are useful, and at a final plateau, where sufficient resources are available that they do not limit output but do have diminishing returns (cf. Horn and Rubenstein 1984). Here, a risky choice is one of mating early at a high cost to future condition, particularly where a useful threshold level has not been reached. More specifically, if an individual could have waited and been in better condition later, with more resources, a better outcome is likely; thus, saving resources for later use is the more successful choice.

The shape of the return curve has important implications. If the return curve is not sigmoidal but linear or exponential, there is no point of diminishing returns (Kaplan et al. 1995). If investment in offspring continues to yield benefits (perhaps for future continuation of a lineage), then a strategy of very high investment in very few offspring may be most effective (Kaplan 1994). The environmental factors that are included in the reproductive value equation are the probability of survival to age x and the discount for worse conditions at age x. Both factors change the value of a future return versus an immediate one. To the extent that the future is unstable, early risk-taking, specifically early reproduction, would be an optimal choice. There is increasing evidence that consistency of contraceptive use by young women is correlated with markers of future work opportunity (enrollment in school, employment experience, wages; Cooksey 1990; Kraft and Coverdill 1994), concordant with predictions from life history theory.

Thus, a model for predicting the effectiveness of taking a current risk will involve one's assessment of its present and future benefits and costs. Costs and benefits of risk-taking depend on environmental characteristics such as the types of life-course pathways available, and the probability of future survival to various ages, as well as the factors of

sex, history of predictability, and future predictability beliefs. Conservative, saving-oriented strategies are favored when future success is predictable and a long lifespan is expected. Otherwise, when one's environment is unpredictable or survival probability is low, there is less chance that one will live long enough to encounter any negative consequences of risk-taking, so high-risk strategies may be preferable.

FUTURE DIRECTIONS

The "current versus future" perspective is a helpful model for understanding early reproduction or risk-taking, yet more research in several areas is needed to understand the phenomenon more fully. For example, there is a need for more elaboration of life history models. Although empirical studies are few, scattered, and incomplete, we suggest that patterns which are widespread in other species may have homologues in humans. Human social complexity makes analysis complicated. In this paper we simply present some relevant intriguing questions, and we suggest the sort of data needed to test whether the possible relationship is real. These ideas would be highly relevant for understanding patterns thought to be paradoxical or aberrant (e.g., reproducing early or having more children than can be supported with available resources). To gain a fuller understanding, more research will have to be conducted on (1) role of age-specific mortality patterns, (2) measures of resource predictability, and (3) dynamic investment decisions in a variable environment.

1. *Age-specific mortality.* The relative risks faced by adults versus juveniles affect parental care patterns in other species. High or unpredictable (extrinsic) adult mortality leads to a concentration of parental effort: reduced iteroparity (in many species, this reaches the extreme of semelparity—one reproductive bout in a lifetime), and very low per capita investment in offspring (e.g., Roff 1992, Stearns 1992, and references therein). When juvenile mortality is also high or unpredictable, rapid maturation also occurs. When adult mortality is low, repeated reproduction (iteroparity) is common, and if adults can further reduce juvenile mortality by increased care of offspring, we see repeated reproduction with great per capita investment in juveniles (and, of course, fewer offspring as a result). In unpredictable environments, parental strategies are favored that make the probability of success of individual offspring independent. If adult mortality is low, this will mean iteroparity (placing a small reproductive *bet* each time environmental conditions are favorable). When adult extrinsic mortality is high, this outcome can be accomplished in semelparous species by separating offspring

spatially. Thus, safe adults will reproduce repeatedly, hedging their bets, and further will extend care and protection to offspring; adults with high or uncertain mortality will simply reproduce quickly, producing as many relatively independent offspring as possible before they die.

To describe human patterns over the lifespan, we need more data regarding individuals' reproductive behavior, from age of maturation to care of grandchildren. As described in the introduction to this article, humans do form perceptions of adult mortality probabilities (Burton 1990; Chisholm n.d.; DuRant et al. 1994; Geronimus 1996), and their conceptions of optimum pacing of a truncated life course may be quite coherent (Geronimus 1996). Wilson and Daly (1997) speculate that humans may indeed perceive the distribution of deaths of relatives and acquaintances, forming a quasi-statistical impression of their own probability of survival that may or may not be conscious. Evidence is accumulating that subjective perceptions of mortality are reasonable predictors of measures related to the early onset of reproductive career (Chisholm n.d.; Geronimus 1996). As in other species, adult humans' higher mortality is expected to relate to earlier onset of reproduction, holding resources constant. Much more research is needed to address such issues.

2. *Measuring pattern of environmental resources for contemporary humans.* In order to apply theory from behavioral ecology to humans, ecological parameters will have to be translated to fit socioeconomic measures appropriate for people. Resources such as money, critical for humans, cannot yet be measured and included in a characterization of environmental unpredictability in the same way that food, shelter, nest sites, weather, predator distribution, and so forth, are. In other species, external environmental conditions have been shown to influence the relative profitability of reproducing at particular times. Ample historical and cross-cultural data suggest that (at an aggregate level) humans also shift reproduction depending on environmental conditions (Easterlin 1980). For example, marriage rates in England (Wrigley and Schofield 1981) and Sweden (Low 1991) have varied historically with the cost of living.

Most analyses of resource variation in human economics have not separated pattern in resources from amount of resources. The first extensive attempt to map social class onto ecological parameters was presented by Weinrich (1977). He described resource predictability, "The expected unpredictability of one's future income stream," as the salient economic difference between lower and middle social classes. His research related economic predictability to the durability of cooperative parental bonds. Compared with a white-collar career, a future income stream based on working-class jobs will entail a higher probability of

job-related injury and periods of unemployment. Nelkin's (1970) ethnographic study of migrant farm workers eloquently described the extreme unpredictability of their jobs. According to one worker, "This traveling stuff is not good. You can't predict the weather, you can't predict what's going to happen, you can't predict the good days or the bad days, so nine times out of ten you end up with some kind of complication and no work. You do pretty good for a week and then have no work at all, so it just doesn't add up to anything" (1970:479).

There is a need for good measures of environmental resource variation for use in human life history studies. We have used childhood socioeconomic stress and parental impairment in previous work, showing that these factors are independently associated with younger age at marriage and fewer years of education (Hill et al. 1997). These factors are likely to be sources of environmental unpredictability, but the measures are broad and general. One area in which advances are being made relates to family unreliability. Family unpredictability has been addressed by developing a new measure, the Family Unpredictability Scale (FUS; Ross and Hill n.d.b), which separates consistency of parental behavior from amount or type. The FUS refers to inconsistent family unreliability in the areas of meals, money, nurturance, and discipline. Inherent in this construct is unpredictability in parental investment. Although not discussed in detail in the Results section above, family unreliability was more helpful in predicting risk-taking than standard measures of adverse environment (parental absence, poverty, and neighborhood crime), probably because it captured the realm of environmental unpredictability better. The construct of parental investment is not unidimensional. Barber's (n.d.) factor analysis of a set of measures related to parental investment in a college student sample found separate factors for items related to family composition and structure (family size, divorce) and those related to parental relationships and behavior. We will continue our work in the area of family functioning.

3. *Dynamic investment decisions in a variable environment.* Environmental variability will affect the utility of producing offspring that may not receive sufficient investment (as we seem to assume teenage mothers do). Humans appear highly able to fine-tune investment decisions to their circumstances. Classic studies in the application of evolutionary biology to human psychology and anthropology have shown differential parental investment patterns by sex (Trivers and Willard 1973) and biological relatedness (Daly and Wilson 1985a).

Abortion or abandonment of offspring represents an extreme investment decision. Because each infant requires extensive investment, investment biases, even to the extent of infanticide, can sometimes be reproductively profitable (Daly and Wilson 1988; Hrdy 1992). Rates of

abortion, neglect, child abandonment, and infanticide show correlations with both extrinsic economic conditions, and maternal ability to invest (e.g., too-close births, twins, lack of an investing male; Bugos and McCarthy 1984; Daly and Wilson 1988). Selective reasons for terminating investment in an offspring include mother's inability to invest, her lack of access to additional resources (family, mate), child's unlikeliness to succeed, and the economic and reproductive value of other existing or potential children. Abortion appears more common in circumstances in which the birth of the child is likely to reduce the mother's lifetime reproductive success (Hill and Low 1992; Torres and Forrest 1988). Child abandonment, like abortion, appears to have resource availability correlations; it has been shown to relate to economic factors and mother's abilities in historical studies in France (Fuchs 1984), Spain (Sherwood 1988), and Russia (Ransel 1988). Similarly, Boswell's (1990) historical overview of child abandonment reveals that most cases were related to maternal ability to invest, despite great variation in period, nationality, and other circumstances.

Why produce children who may be neglected or abandoned? In other species, the production of "excess" offspring may be an adaptive response to a variable environment (Roff 1992; Stearns 1992). If the initial cost of producing offspring were not high, supernumerary offspring might serve as a guarantee where one offspring may die or where an extra offspring can survive in good years. Raptors offer an extreme example of this, where scarcity of resources can cause siblicide. Many raptors start clutches well before the period of high prey availability in which the parents will feed their young. Unequal investment allows parents to raise fewer, better-invested offspring (e.g., three large healthy offspring rather than four puny, unsuccessful ones). Raptors begin to incubate as each egg is laid; thus in a clutch of four, the oldest offspring is two days older than the next largest offspring, and six days older than the youngest. The oldest offspring not only is larger, and has a competitive advantage over its siblings, it also is more valuable—it has fewer chances to die before reproduction, and thus its reproductive value (Fisher 1958) is higher. Hence, when resources are insufficient to raise all offspring successfully, investment goes to the most valuable offspring.

Few long-term data based on individual and family lifetimes are available for humans, relative to other species, to allow us to examine whether risk-taking, or specifically producing excess young, may be a response to a variable environment. Favoritism within biological families has rarely been studied but may affect an individual's perception of his or her value to the parents. Such subjective assessments could be linked to reproductive value and might affect one's reproductive or risk-taking choices. Hill et al. (1994) found some evidence that recollection of parental

favoritism affected adult relationships. Presumably, individuals who experienced reliable, consistent parental investment of resources will expect a stable environment and are more likely to choose survival rather than take a dangerous risk. An additional prediction following from life history considerations might be that supernumerary offspring, vulnerable to later neglect, would be more common in unpredictable environments, compared with an environment where resources were scarce but stable.

CONCLUSION

Analytic risk-taking models used in the social sciences may be improved by including concepts borrowed from life history theory. Consideration of the life course in a Darwinian/adaptationist framework illuminates typical or modal tendencies for risk-taking to vary by age and sex. Further, individual differences in the rate of discounting future benefits can be better understood. When the decision to take or forgo a risk is conceived as buying or risking survival to use the effort in the future, "discounting the future" has more concrete meaning. It is reasonable to predict that people are sensitive to indicators of their own reproductive value, whether consciously or not. That includes the three basic elements of Fisher's (1958) definition of reproductive value (survival expectation, expected reproductive output, and discount for future conditions being worse). Psychological research has far to go to determine humankind's mental models of these biologically important factors.

Given these conclusions, a prediction follows that stable environments with an array of means for long-term success would foster future-oriented people. Parents whose practice is one of predictability, ranging from consistently responding to a child's behavior to establishing and carrying out family rituals, should enhance children's view of the future as controllable, predictable, and stable (cf. Emshoff 1989). However, the larger environmental context will be important. The subjective discount rate should be responsive to factors that increase return from survival, such as spending time gaining an education. Public policy-makers who attempt to change teenage childbearing patterns or youthful violence should keep life course patterns in mind. Modifying only the current costs (disadvantages) without changing the array of future choices may have little effect when the discount rate is very high. No change in early reproduction or risk-taking would be predicted by life history theory unless the return from investment in survival to a better future were changed.

The authors wish to thank the instructors at local community colleges for allowing access to their classes for data collection. Work described herein was supported by NIAAA grant T32 AA07477. A preliminary version of this paper was presented at the meetings of the Human Behavior and Evolution Society, June 1996, Northwestern Universeity, Evanston, Illinois.

Elizabeth Hill, who received a Ph.D. from Tulane University, is associate professor of psychology at the University of Detroit Mercy and an adjunct faculty member with the University of Michigan Alcohol Research Center. She studies the development of alcoholism using an evolutionary analysis of the environment, particularly the subtheories of parental investment and life history theory.

Lisa Thomson Ross received a Ph.D. in social psychology from Wayne State University. She completed a postdoctoral fellowship at the University of Michigan Alcohol Research Center and is currently a research investigator at the University of Michigan School of Nursing. Her research relates to family unpredictability and social predictors of drinking, risk-taking, and mental health.

Bobbi S. Low is professor of resource ecology at the School of Natural Resources and Environment, University of Michigan. Her background is in behavioral and evolutionary ecology, and her current interests are human sex differences in risk-taking and resource use.

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