ELSEVIER

Evolution and Human Behavior 23 (2002) 281–295

Evolution and Human Behavior

Sex differences and statistical stereotyping in attitudes toward financial risk

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Received 5 June 2001; received in revised form 6 January 2002; accepted 10 March 2002

Abstract

Subjects in a laboratory experiment completed the Zuckerman Sensation-Seeking Scale (SSS) then chose among five alternative gambles with substantial financial stakes. The gambles differed in expected return and variance. Gambles were presented in one of two different frames in a between-subjects design. In one, subjects were paid a fixed sum for completing the survey and that sum was then at risk in the subsequent gamble choices. In the other, all payoff amounts for the gambles were nonnegative. Subjects were paid according to their choices and the outcomes of the gambles. We tested for sex differences in this choice task and found women to be consistently more risk averse, on average, than men. We observed no difference across frames. Subjects were then asked to guess the gamble choices of each of the other participants and were rewarded for each correct answer. Subjects of both sexes did substantially better than chance in guessing the particular choices of individuals of both sexes, but both men and women overestimated the risk aversion of others, especially that of women, and most strongly of all with respect to men's predictions of women's choices. Possible real-world implications of biased assumptions about women's risk attitudes are discussed.

Keywords: Sex differences; Risk; Gambles; Sensation-seeking; Stereotyping

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1090-5138/02/$ – see front matter
PII: S1090-5138(02)00097-1

1. Introduction

Women typically are thought to be more risk averse than men. Women engage in less risky or aggressive behavior and are more averse to risk in many aspects of their lives. Differences in behavior are more marked in some societies than others, but across a wide variety of environments and social structures, women avoid risk (e.g., Flynn, Slovic, & Mertz, 1994; Jianakoplos & Bernasek, 1998; Levy, Elron, & Cohen, 1999; Powell & Ansic, 1997; Spigner, Hawkins, & Lorens, 1993).

The term "risk" has many different meanings and interpretations. (See MacCrimon & Wehrung, 1986 for a discussion of elements of risk and risk aversion.) In this study, although we refer to a number of different risk-related choice phenomena, our experiments involve risk measured as the variance in possible payoffs associated with a given choice.

The primary argument for an evolved basis for the observed sex difference in attitudes toward risk arises from the marked difference faced by the sexes in the returns to alternative investments in reproductive success. For females, the low-risk steady-return investment in parenting effort often yields the highest returns, whereas for males, the higher-risk investment in mating effort produces a higher expected payoff (see Daly & Wilson, 1988, Chapter 7; Geary, 1998, pp. 42–45; Low, 2000, Chapter 4; Rubin & Paul, 1979). Successful parenting consists in part of avoiding risks to oneself and one's offspring. In contrast, successful competition for mating opportunities often involves highly risky strategies. A successful risk-taker acquires superior material resources, enhancing his value as a mate.

Optimal investment behavior would generally require that an agent invest in two alternative activities until the expected returns, adjusted for risk, were equal, yet peoples of many hunter-gatherer societies appear to overinvest in the pursuit of high-variance food resources (Hawkes, 1991, 1993; Hawkes, O'Connell, & Blurton Jones, 2001; Hill & Kaplan, 1993; Kaplan & Hill, 1985a, 1985b; Smith & Bird, 2000). This may be due in part to the display value of a successful hunt. Hunters who can engage successfully in the risky activity of hunting large animals signal their superior fitness (Smith & Bird, 2000). While hunting appears to be an inefficient means of producing calories, research shows that successful hunters have more, and healthier, offspring, reinforcing the notion that successful hunting increases sexual access (Kaplan & Hill, 1985a).

In addition to greater risk aversion, an evolutionary approach suggests that women may be particularly sensitive to the possibility of losses. If females have a primary focus on investment in parenting, then they may be particularly averse to strategies that entail the possibility of negative payoffs. Dependent, immature offspring are more sensitive to fluctuations in resources and more likely to die as a result of a temporary shortage of food. Females are thus more likely than males to exhibit loss aversion in behavior. For this reason, we designed our experiments to distinguish risk aversion from loss aversion.

Research on modern societies has found differences between women and men in risk perceptions and risk tolerance. Examples of recent studies of differences in risk perceptions include Spigner et al. (1993) on perceptions of the risk attached to alcohol and drug use, Flynn et al. (1994) on the catastrophic potential of nuclear war, technology, radioactive waste, industrial hazards, and environmental degradation, and Boverie, Scheuffele, and

Raymond (1995) on the perceived risk of various recreational and social activities. As regards risk-taking, men are more likely to gamble (Levin, Snyder, & Chapman, 1988), to pursue "direct risk" health-related behavior (Kristiansen, 1990), and to engage in unprotected sex while infected with a sexually transmitted disease (Swanson, Dibble, & Trocki, 1995). Participants in homicide are overwhelmingly young men (Daly & Wilson, 1988; Wilson & Daly, 1985.)

As economists, our primary interest is in the extent to which these patterns of behavior carry over into financial decision-making. Recent research supports a similar sex difference in risk acceptance in financial arenas. On average, women are found to have less risky asset portfolios than men (Jianakoplos & Bernasek, 1998), to report lower willingness to accept financial risk (Barsky, Juster, Kimbal, & Shapiro, 1997), and to be more risk averse towards gambles (Levin et al., 1988). In addition, several laboratory experimental studies find women to be more risk averse than men in settings designed to mimic investment behavior (e.g., Powell & Ansic, 1997). A lower willingness to accept risk can be costly to women investors. Levy et al. (1999) compared the investment decisions of male and female MBA students over several weeks and found that women's greater risk aversion significantly lowered their earnings relative to men.

Many risky activities involve the potential for significant losses, and to our knowledge, researchers have not been able to disentangle variance aversion from loss aversion in nonfinancial field settings. While there are a number of studies confirming loss aversion in the general population (see Bateman, Munro, Rhodes, Starmer, & Sugden, 1997; Kahneman, Knetsch, & Thaler, 1991; Tversky & Kahneman, 1991), we know of no experimental studies that specifically investigate sex differences in loss aversion. Our experiment in part addresses this gap.

Differences in behavior between women and men may be the result of differences in underlying preferences for risk, but they might also be caused (or exacerbated) by differences in the options presented to women or the investment advice they receive. If there is a general perception that women are more risk averse than men, then women may not be offered the same kinds of risky but beneficial opportunities offered to men. For this reason, we designed our experiments to measure not only differences between women and men in attitudes toward financial risk but also the differences in expectations that women and men hold about each other's behavior.

Our study consists of a "decision task," which was designed to measure risk attitudes, and a "forecasting task," which measures the perceptions of risk attitudes by others. The decision and forecasting tasks were presented in two different decision environments. In the first, subjects were paid $6 for completing the Zuckerman Sensation-Seeking Scale (SSS), which is described below. In this frame, the riskier choices included the possibility of losses up to $6. Subjects in the second decision frame also completed the SSS but were not paid for it, and the payoffs of the gambles were scaled up by $6, removing the possibility of losses. These frames were designed to discover whether women's tendency to avoid risk might be due to loss aversion rather than variance aversion. We correlated these with the SSS-Form V (Zuckerman, 1979, 1994), a 40-question survey instrument designed to assess individual differences in preferences for seeking out novel and stimulating activities, attitudes, and values and

further exploring them. We included this instrument in part to test for the presence of a domain-general, risk-seeking personality type.

The SSS-V has been widely used and found to be correlated with a variety of risky behaviors including crime, sports, drug and alcohol consumption, driving, and sexual behavior (e.g., Daderman, 1999; Dervaux et al., 2001; Freixanet, 1999; Heiono, van der Molen, & Wilde, 1996; Schroth, 1996). It contains four subscales, each consisting of 10 items, measuring different aspects of sensation seeking. The Disinhibition (DIS) factor measures nonconformity with standards of acceptable social behavior. Drinking, gambling, and sex achieve this type of sensation. The Boredom Susceptibility (BS) factor measures aversion to routine in one's life and intolerance of boring people. The Thrill and Adventure Seeking (TAS) factor measures preference for the thrills inherent in risky activities such as parachute jumping. Finally, the Experience Seeking (ES) factor addresses the preference for mentally arousing activities and a nonconforming lifestyle.

Economic theory typically treats risk aversion as a property of a domain-general utility function, which serves a purpose in economic modeling of behavior similar to that of a fitness function in biology. The concavity of the function determines the degree of risk aversion. In contrast, while some research in psychology focuses on the domain-generality of a measure such as the Zuckerman SSS (Ripa, Hansen, Mortensen, Sander, & Reinisch, 2001), other research highlights differences in risk assessment and risk acceptance across domains (Hattis & Anderson, 1999; Lopes, 1992; Slovic, 1999; Smith, 1992).

1.1. Experimental design

Subjects completed three tasks in one of two treatments: Loss or No-Loss. At the beginning of the session, we administered the Zuckerman SSS. In the Loss treatment, subjects were paid $6 for completing the survey. Subjects were paid for completing this task rather than being granted the $6 so that they would feel entitled to the money, increasing the salience of possible losses. This procedure was designed to minimize any "house money" effect, i.e., the phenomenon that subjects make riskier choices when playing with the experimenter's money rather than their own. For the No-Loss treatment, subjects were not paid for completing the survey.

We then conducted the decision task, where each subject selected one from among five gambles. To indicate a choice, the subject marked the desired decision on a decision form. Choices were private and could not be observed by other subjects. As shown in Table 1, each gamble had two possible outcomes, each occurring with 50% probability. Payments for the Loss and No-Loss treatments differed by $6 as shown, with all payoffs nonnegative in the No-Loss treatment. Table 1 indicates the expected value and variance of each gamble. Subjects did not see this information. Gamble 1 had a sure payoff of $10 or $16 depending on the treatment. The expected value increased by $2 for each additional gamble, and the standard deviation (S.D.) also increased. Subjects who were extremely risk averse would sacrifice expected payoff to avoid variance, choosing the sure bet. A moderately risk-averse individual would choose an intermediate bet (Gambles 2–4). However, risk-neutral or risk-seeking subjects would choose Gamble 5, with an expected return of $18 or $24. (Note that a

Table 1
Gamble choices, expected payoffs, and risk in the two alternative framings

Gamble choice	Event	Probability (%)	Payoff		Expected payoff		Risk
			Loss framing ($)	No-Loss framing ($)	Loss framing ($)	No-Loss framing ($)	
1	A	50	10	16	10	16	0.00
	B	50	10	16			
2	A	50	18	24	12	18	4.24
	B	50	6	12			
3	A	50	26	32	14	20	8.48
	B	50	2	8			
4	A	50	34	40	16	22	12.73
	B	50	−2	4			
5	A	50	42	48	18	24	16.97
	B	50	−6	0			

The level of risk is represented as the S.D. of expected payoff.

risk-neutral person will maximize expected payoff by choosing Gamble 5. A risk-seeking person will choose a higher-risk option even if it involves the same or lower expected payoff, so any risk-seeking person will also choose Gamble 5.) In the Loss treatment, Gambles 4 and 5 entailed a negative payoff should event B occur, and these amounts were deducted from the payment for completing the SSS. Losses were eliminated in the No-Loss treatment by scaling payoffs up so that the lowest outcome was zero. In the Tversky-Kahneman (1991) framework, loss aversion is represented as a change in the slope of the utility function, with losses more salient than gains (i.e., the utility function has a steeper slope in the loss domain). Even if a person is risk neutral (i.e., the utility function is linear in income), this change in slope introduces a concavity to the utility function that can induce choices that appear to be risk averse. A comparison of choices in the Loss and No-Loss treatments can distinguish whether the choices are due to risk or loss aversion.

Finally, subjects were presented with the forecasting task. Each was asked to guess what decision had been made by each of the other subjects in the same session. To induce subjects to reveal their true beliefs about the risk attitudes of others, they were paid $1 for each correct guess.

1.2. Procedure

Subjects ($n = 204$) were recruited from undergraduate social science and business courses at Saint Cloud State University (SCSU) and Virginia Polytechnic Institute and State University (VPI). These undergraduates were asked to volunteer to report at a specified time and location to participate in an experiment for which they would be paid. Thirteen sessions were conducted with 7–21 volunteers per session. Participants were distributed as follows: 149 participated in the Loss treatment (eight sessions) and 55 in the No-Loss treatment (five sessions).

As subjects arrived at the experimental location, each was randomly assigned to a seat at a table. All subjects were seated so that they could not observe each other's decisions but had

otherwise unobstructed views of the others. Consent forms were distributed, signed, and collected. The experimenter distributed a packet containing written instructions for each of the three parts to the experiment and all necessary forms. The written instructions also were read aloud in turn for each part of the experiment, and forms were collected before proceeding to the next component. (All instructions and forms are available upon request from the authors.)

Subjects completed the SSS survey using scantron sheets. For the decision task, subjects indicated on a separate form which of the five gambles they wished to play. They were informed that each subject would later roll a six-sided die to determine which of the two events occurred. If a 1, 2, or 3 was rolled, Event A occurred. If a 4, 5, or 6 was rolled, Event B occurred. Subjects in the Loss treatment were informed that if they selected "...either Gamble 4 or 5 and Event B occurs, your losses will be deducted from your $6 fee for completing the survey..." The die rolls for the choice task were performed after the forecasting task was completed. For the forecasting task, each subject stood in turn and was visible to all others in the room. The other subjects indicated on their prediction forms which of the five choices they thought the standing person had chosen. For every correct prediction, they received a $1 bonus. Forms were collected and matched with decisions, and payoffs for this task were calculated.

The experimenters then returned the gamble choice forms to the subjects, and each person rolled a die to determine earnings on the gamble. While the total earnings were being calculated outside the room, participants completed a brief survey collecting demographic information and answers to debriefing questions. Everyone was paid the amount of money they earned for all aspects of the experiment, privately, in cash.

2. Results

2.1. Subject characteristics

Of the 204 participants, 200 provided useable responses: 104 male and 96 female. (Four subjects did not fully or correctly complete either their prediction forms or subject information surveys and were dropped from the sample.) The mean age of subjects was 20 (S.D. = 1.91). Consistent with the student populations at the two schools, subjects were overwhelmingly Caucasian (approximately 80%). Forty-two percent of the subjects were majoring in economics or business.

Overall, our data showed no significant demographic differences between male and female subjects, except that women were more likely to be employed, either full- or part-time, than men (68.7% vs. 51.0%). This variable did not covary significantly with gamble choices for either sex.

2.2. Gamble choice

The distribution of subjects by treatment over gamble choices is reported in Table 2. For the purpose of analysis, we treat number of the subjects' gamble choice as a continuous

Table 2
Frequency distributions of gamble choices in relation to the subject's sex and the framing treatment

	All subjects		Men		Women	
Gamble choice	Loss framing	No-Loss framing	Loss framing	No-Loss framing	Loss framing	No-Loss framing
1	7	3	2	0	5	3
2	25	10	11	6	14	4
3	48	17	15	10	33	7
4	32	9	18	6	14	3
5	36	13	26	10	10	3
Total	148	52	72	32	76	20
Mean gamble choice (S.D.)	3.44 (1.17)	3.37 (1.22)	3.76 (1.18)	3.63 (1.13)	3.14 (1.08)	2.95 (1.28)

variable. The number of the gamble is an index measure of the (continuous) underlying risk level associated with the gambles. Choices are discrete but not categorical. Alternatively, we could have conducted the analysis using the coefficient of variation of the gamble chosen by the subject, which is a monotonic transformation of the gamble number, with results identical to using the gamble number itself.

Consider first the framing of the choice. We found no evidence that framing affected subjects' choices. In pairwise Epps–Singleton tests (Epps & Singleton, 1986; Forsythe, Horowitz, Savin, & Sefton, 1994), we tested for treatment differences within each sex considered separately and were unable to reject the null hypothesis that either men's or women's choices were drawn from the same distribution across the two treatments [men: $\chi^2(4) = 2.55$, $P =$ ns; women: $\chi^2(4) = 1.28$, $P =$ ns]. Likewise, in pairwise means tests within sex, we found no significant difference between men's and women's gamble choices across the two frames [men: $t(103) = 0.57$, $P =$ ns; women: $t(95) = 0.58$, $P =$ ns]. Our results thus indicate that loss aversion alone was not responsible for the difference between the choices of women and men that we observed in our Loss treatment. We repeated the analysis, treating the data as categorical and using log-linear analysis for categorical frequency data, and again found that gamble choice was unaffected by frame. Neither the second-order effects of gamble choice/frame and sex/frame nor the third-order effect of gamble choice, sex, and frame contributed significantly to explaining our data. Details are available on request. For the remaining analysis, we combined the data from the two frame treatments.

Comparing men's and women's gamble choices, we found that women were significantly more risk averse than men. For example, less than 2% of the men, but over 8% of the women, chose the least risky gamble, whereas over one-third of the men, but only 13% of the women, selected the riskiest gamble. The median gamble choice was 4 and 3 for men and women, respectively. Men's mean gamble choice was 3.72 (95% confidence intervals: 3.49–3.95) versus 3.10 (2.87–3.33) for women, a significant difference [$t(198) = 3.83$, $P < .001$]. Again, log-linear analysis confirmed this finding. The second-order effect of gamble choice and sex was the only important second-order effect. Fitting the log-linear model {frame, gamble choice|sex} gave a $G2 = 7.32$, $df = 9$.

Table 3
Scores on Zuckerman SSS-V and its four subscales by sex

	All subjects ($N=200$)	Men ($n=104$)	Women ($n=96$)	t (two-tailed P)
Total (S.D.)	21.3 (5.7)	21.6 (5.8)	21. (5.5)	0.70 ($P=.24$)
DIS (S.D.)	5.5 (2.4)	5.9 (2.4)	5.1 (2.4)	2.18 ($P=.02$)
BS (S.D.)	3.9 (2.1)	4.2 (2.1)	3.6 (2.0)	2.16 ($P=.02$)
TAS (S.D.)	6.7 (2.7)	6.7 (2.9)	6.6 (2.5)	0.25 ($P=.40$)
ES (S.D.)	5.2 (2.2)	4.8 (2.2)	5.7 (2.1)	2.99 ($P=.01$)

Table entries are means (S.D.).

Summary data on the SSS scores are shown in Table 3. Each subscale can range from 0 to 10. The overall measure can range from 0 to 40. We found no significant sex difference in the overall scale, although women scored significantly lower than men on DIS and BS and higher on ES. We further analyzed the SSS data by multiple regression, with subjects' sex, age, employment status, academic major, and whether they were first-born children as predictors. Even after controlling for all factors other than sex, the results reported in Table 3 were unchanged: sex was insignificant as an explanatory variable for total score and TAS, was significantly positively correlated with DIS and BS, and was significantly negatively correlated with ES. (Details of the estimation are available from the authors.)

Most importantly, we found very low correlations between the SSS scales and gamble choices for both men and women. Neither the total score nor any of the four subcomponents were significantly correlated with gamble choice for either sex. (Rietz, Daly, & Wilson, 1998 report a similar result correlating SSS scores with an alternative financially risky task.) For men, the correlation coefficients were $-.036$, $-.031$, $-.048$, $-.110$, and .128 for Total, DIS, BS, TAS, and ES, respectively. For women, coefficients were .060, $-.101$, .088, .129, and .037 for Total, DIS, BS, TAS, and ES, respectively. In no case did the corresponding z-statistic exceed 1.30 ($P=$ ns). Thus, the SSS lacked predictive power with respect to this financially risky decision.

2.3. Gamble forecasts

We first considered whether forecasts differed by framing treatment. Using Epps–Singleton tests, we were unable to reject the null hypothesis that the distribution of decisions in the forecasting task was the same across frames for all target/predictor combinations. [For men predicting men's choices: $\chi^2(4)=4.64$, men predicting women's choices: $\chi^2(4)=8.25$, women predicting men's choices: $\chi^2(4)=2.44$, and women predicting women's choices: $\chi^2(4)=1.30$; all $P=$ ns.] For the remaining analysis, we combined the data from the two framing treatments.

Table 4 presents the gamble predictions by sex as well as by treatment of the predictor and sex of the person whose choice was being predicted. Consistent with actual gamble choices, men were predicted to be less risk averse than women by both sexes. Predictions by both men and women for men were strongly skewed to the riskier gambles, while predictions for women were strongly skewed to the least risky gambles. The mean prediction by men for

Table 4
Distribution of gamble predictions by sex of the predictor and the decision-maker

	Predictions by men		Predictions by women	
Gamble	For men	For women	For men	For women
1	71	170	57	139
2	144	295	169	241
3	212	191	220	228
4	179	74	219	102
5	182	73	138	58
Mean prediction (S.D.)	3.33 (1.26)	2.48 (1.19)	3.26 (1.18)	2.61 (1.15)

men of 3.33 was significantly greater than their mean prediction of 2.48 for women ($t = 13.73$, $P < .001$). Women predicted a mean gamble of 3.26 for men but only 2.61 for women, also a significant difference ($t = 11.17$, $P < .001$).

Both sexes overestimated the risk aversion of both sexes, but to varying degrees. Men and women had mean actual gamble choices of 3.72 and 3.10, respectively, but the mean predictions of those choices were just 3.29 and 2.54, respectively. In both cases, difference between actual and predicted was highly significant [men: $t(103) = 3.62$, $P < .001$; women: $t(95) = 4.75$, $P < .001$]. Neither sex did better in predicting its own sex's level of risk aversion. Both produced estimates that were significantly lower than actual gamble choices (for men: actual = 3.72 vs. predicted = 3.33, $t = 3.23$, $P < .001$; for women: actual = 3.10 vs. predicted = 2.61, $t = 4.08$, $P < .001$). Finally, there was consensus between the sexes regarding men's risk aversion but not women's. The mean predictions for men did not differ significantly by sex (3.33 by men vs. 3.26 by women, $t = 1.06$, $P =$ ns), but men underpredicted women's risk acceptance even more than did women (2.48 and 2.61, respectively, $t = 2.12$, $P < .02$).

We next address the accuracy of the predictions made by women and men. Table 5 reports correlation coefficients for actual gamble choices and average predicted gamble choices. This analysis tests whether the target conveyed a clue about his/her risk preference that was picked

Table 5
Correlation coefficients for actual and mean predicted choices

Target/predictor	*r*	n (targets)	*Z*	P
All/all	.417	200	6.23	< .001
All/females[a]	.358	199	5.24	< .001
Males/females	.349	104	3.66	< .001
Females/females[a]	.427	95	4.38	< .001
All/males	.386	200	5.72	< .001
Males/males	.366	104	3.86	< .001
Females/males	.416	96	4.27	< .001

[a] There was one session with six men and only one woman.

Table 6
Distribution of gamble predictions by target's actual gamble choice (column-wise percentages in parentheses)

	Gamble choice				
Prediction	1	2	3	4	5
1	*54 (33.5)*	116 (21.2)	111 (11.0)	47 (6.9)	109 (14.2)
2	39 (24.2)	*219 (40.0)*	298 (26.9)	121 (17.9)	172 (22.4)
3	31 (19.3)	128 (23.4)	*326 (32.3)*	208 (30.7)	158 (20.6)
4	13 (8.1)	61 (11.1)	193 (19.1)	*208 (30.7)*	99 (12.9)
5	24 (14.9)	24 (4.4)	81 (8.0)	93 (13.7)	*229 (29.9)*
Number making choice	10	35	64	42	49
Total number of predictions	161	548	1009	677	767
Mean prediction	2.47	2.38	2.84	3.26	3.22

up by both men and women. We therefore used an average prediction estimate for each target. We found a significant positive correlation between actual choices made by all subjects and the predictions of those choices ($r = .417$, $P < .001$). Men and women differed little in their overall ability to predict the choices made by others ($r = .358$, $P < .001$ and $r = .386$, $P < .001$, respectively). Within sex pairings, both sexes were better at predicting women's than men's choices, but not significantly so.

Table 6 shows the distribution of individual forecasts in relation to actual choices. Counts on the diagonal represent correct predictions, which constitute the modal prediction for all choices, again showing that prediction was much better than chance. However, for each gamble choice, 60–70% of the forecasts were incorrect, so although subjects were good at predicting whether others were above or below average in their risk attitudes, they were far from perfect.

3. Discussion

Women and men differ in their attitudes toward many types of risk. Studies document differences both in the perception of risk and in risk tolerance across a variety of decision environments. These patterns may be the result of evolved strategies that reflect differences in the costs and benefits of sex-linked alternative investments in reproductive success. An evolutionary approach also suggests that women may be particularly averse to situations involving potential losses. The tendency of women to be more averse to risk and the potential for loss is likely to be echoed in agents' perceptions of the risk attitudes of others. Important consequences may arise if there is a perception of greater risk aversion on the part of women. If women are, rightly or wrongly, thought to be more risk averse, this stereotype can lead to statistical discrimination, which could adversely affect women in many aspects of their lives.

Overall, our results indicated that women were, on average, more risk averse than men in gamble choices. Women were more than four times as likely as men to choose the risk-free

gamble and about one-third as likely to choose the highest-risk gamble. These results were consistent with the pattern of risk attitudes to be expected from the evolutionary pressures discussed above. However, we found no evidence of greater loss aversion on the part of the women in our sample: the distribution of gamble choices was not different between the Loss and No-Loss treatments, comparing either overall or within-sex distributions. Indeed, unlike previous studies (Bateman et al., 1997; Tversky & Kahneman, 1991), we find no evidence of loss aversion at all in our data.

In contrast to previous studies, subjects' choice behavior was not significantly related to any component of the Zuckerman scale. This may be due in part to our sample of subjects. The values of our measures showed somewhat different patterns from those Zuckerman reported for undergraduate psychology majors. Our women scored substantially higher than his on two of the four subscales (BS and ES) and about the same on the other two, while our men scored significantly lower on TAS and ES (Zuckerman, 1994, p. 100). Values of two of the factors (DIS and BS) were significantly lower for women than for men, consistent with Zuckerman's data. However, ES was significantly higher for women, in contrast to most studies, which find no sex difference in the ES measure. Evidently, our subjects differ from the standard pool of psychology students. More importantly, our results and the corroborating evidence in Rietz et al. (1998) together shed considerable doubt on the existence of a risk-related domain-general personality trait.

Finally, while both men and women anticipated the difference in the average choices of women and men, both sexes were equally weak at assessing within-sex heterogeneity in risk attitudes. Both sexes picked up the tendency for women to be less risk accepting than men, but forecasts were far from perfect. Although correlation coefficients between forecasts and actual decisions were high, between 60% and 70% of forecasts were incorrect. This result indicates to us that both women and men are likely to condition their treatment of women and men according to their (fairly accurate) perceptions about the average differences between the sexes, while there is considerable heterogeneity within sex groupings that is largely not picked up or taken into account.

While sex differences in risk attitudes were presumably adaptive for the environments in which they evolved, they do not seem well suited for modern societies. The economic impact of differences or perceived differences in risk attitudes may be large. Most obviously, higher-risk professions carry higher expected wages. In addition, evidence suggests that women may be investing in suboptimal retirement portfolios because of their misplaced caution (Jianakoplos & Bernasek, 1998; Levy et al., 1999). Both factors translate into lower wages and lower wealth for women.

Any biases exhibited by women are likely to be exacerbated by the perception of greater risk aversion on the part of women. If women are, rightly or wrongly, stereotyped as more risk averse, this can lead to statistical discrimination that could adversely affect women—especially more risk-accepting women—in many aspects of their lives. An individual's choice of strategy may be colored by the sex of the other individual(s) with whom she is interacting. Using visual characteristics such as sex as a signal, an advisor might alter the range of options offered a client to reflect the advisor's perception of the client's risk preferences.

Three examples illustrate the potential importance of perceptions of other's risk attitudes. In healthcare, doctors may tailor their treatment recommendations to reflect their assessment of their patients' risk preferences. For example, studies show that doctors are less likely to prescribe aggressive treatment for women patients compared with men with the same symptoms (e.g., Schulman et al., 1999 and references therein). Other research suggests that these differences may not reflect the preferences of the patients themselves but rather the doctor's assumptions about those preferences (Saha, Stettin, & Redberg, 1999). Furthermore, male and female doctors might differ in their treatment recommendations, reflecting their own personal risk preferences (Lurie et al, 1993).

Similarly, an investment advisor may offer a different range of options to a female than to a male investor, leading to less risky (and less lucrative) portfolios of assets. Indeed, Wang (1994) reports evidence that investment brokers offer women lower risk/lower expected return investments than those offered to men. Grable and Lytton (1999) bemoan the lack of an instrument by which financial advisors can assess the risk preferences of investors and note the reliance of these advisors on demographic characteristics to assess risk attitudes. They note, "This method assumes strong correlations between demographic and socioeconomic characteristics and financial risk tolerance. . .In many cases, heuristic judgments are little more than commonly accepted myths." (p. 165)

Finally, in employment negotiations, the sex of the two parties may influence both the offers made and the aggressiveness with which each party bargains. If women are perceived as more risk averse or less willing to risk the breakdown of negotiation, then women may receive less generous initial offers and face more aggressive bargaining, leading to lower negotiated wages. In a model with two types of workers, Vesterlund (1997) shows that if more risk-averse workers can be identified — for example, if risk aversion is correlated with sex — then that group faces a distribution of wages that is stochastically dominated by the distribution for the less risk-averse group. In addition, Johnson and Powell (1994) argue that women are less likely to be given corporate promotions because they are perceived to be less able to make risky decisions, and Chauvin and Ash (1994) find that women CEOs are paid less largely because of their preference for fixed salaries over performance-contingent (i.e., risky) components of compensation packages.

The potential economic impact of risk preferences and others' assumptions about those preferences can be quite large. A greater awareness of the true distribution of risk attitudes within and between sexes has the potential to lead to better decision-making by women and men.

Acknowledgments

This research was supported by grants from the John D. and Catherine T. MacArthur Foundation (Network on Preferences and Norms, Subnetwork on Sources of Diversity in Risk Acceptance) and from St. Cloud State University, College of Social Sciences. At Virginia Tech, experiments were conducted at the Laboratory for the Study of Human Thought and Action ⟨http://lshta.vt.edu⟩. Colin Camerer suggested the No-Loss treatment. Selhan Garip

and Evan Moore assisted in conducting the experiments, and Bayo Lawal contributed to the statistical analysis. The paper was substantially improved by the generous comments and suggestions of two reviewers and the editors.

References

Barsky, R. B., Juster, F. T., Kimbal, M. S., & Shapiro, M. D. (1997). Preference parameters and behavioral heterogeneity: an experimental approach in the health and retirement study. *Quarterly Journal of Economics*, *112*, 537–579.

Bateman, I., Munro, A., Rhodes, B., Starmer, C., & Sugden, R. (1997). A test of the theory of reference-dependent preferences. *Quarterly Journal of Economics*, *112*, 479–506.

Boverie, P. E., Scheuffele, D. J., & Raymond, E. L. (1995). Multimethodological approach to examining risk-taking. *Current Psychology*, *13*, 289–302.

Chauvin, K. W., & Ash, R. A. (1994). Gender earnings differentials in total pay, base pay, and contingent pay. *Industrial and Labor Relations Review*, *47*, 634–649.

Daderman, A. M. (1999). Differences between severely conduct-disordered juvenile males and normal juvenile males: the study of personality traits. *Personality and Individual Differences*, *26*, 827–845.

Daly, M., & Wilson, M. (1988). Homicide. Hawthorne, NY: Aldine De Gruyter.

Dervaux, A., Bayle, F. J., Laqueille, X., Bourdel, M.-C., Le Borgne, M.-H., Olie, J.-P., & Krebs, M.-O. (2001). Is substance abuse in schizophrenia related to impulsivity, sensation seeking, or anhedonia? *American Journal of Psychiatry*, *158*, 492–494.

Epps, T. W., & Singleton, K. J. (1986). An Omnibus Test for the Two-Sample Problem Using the Empirical Characteristic Function. *Journal of Statistical Computation and Simulation*, *26*, 177–203.

Flynn, J., Slovic, P., & Mertz, C. K. (1994). Gender, race, and perception of environmental health risks. *Risk Analysis*, *14*, 1101–1108.

Freixanet, M. G. I. (1999). Personality profile of subjects engaged in high physical risk sports. *Human Performance in Extreme Environments*, *4*, 11–17.

Forsythe, R., Horowitz, J. L., Savin, N. E., & Sefton, M. (1994). Fairness in simple bargaining experiments. *Games and Economic Behavior*, *6*, 347–369.

Geary, D. C. (1998). Male, female: the evolution of human sex differences. Washington, DC: American Psychological Association.

Grable, J., & Lytton, R. H. (1999). Financial risk tolerance revisited: the development of a risk assessment instrument. *Financial Services Review*, *8*, 163–181.

Hattis, D., & Anderson, E. L. (1999). What should be the implications of uncertainty, variability, and inherent "biases"/"conservatism" for risk management decision-making? *Risk Analysis*, *19*, 95–107.

Hawkes, K. (1991). Showing off: tests of another hypothesis about men's foraging goals. *Ethology and Sociobiology*, *11*, 29–54.

Hawkes, K. (1993). Why hunter-gatherers work: an ancient version of the problem of public goods. *Current Anthropology*, *34*, 341–361.

Hawkes, K. J., O'Connell, F., & Blurton Jones, N. G. (2001). Hadza meat sharing. *Evolution and Human Behavior*, *22*, 113–142.

Heiono, A., van der Molen, H., & Wilde, G. J. S. (1996). Differences in risk experiences between sensation avoiders and sensation seekers. *Personality and Individual Differences*, *20*, 71–79.

Hill, K., & Kaplan, H. (1993). On why male foragers hunt and share food: comment on K. Hawkes. *Current Anthropology*, *34*, 701–710.

Jianakoplos, N. A., & Bernasek, A. (1998). Are women more risk averse? *Economic Inquiry*, *36*, 620–630.

Johnson, J. E., & Powell, P. L. (1994). Decision making, risk and gender: are managers different? *British Journal of Management*, *5*, 123–138.

Kahneman, D., Knetsch, J. L., & Thaler, R. (1991). Anomalies: the endowment effect, loss aversion, and status quo bias. *Journal of Economic Perspectives*, *5*, 193–206.

Kaplan, H., & Hill, K. (1985a). Hunting ability and reproductive success among male Ache foragers: preliminary results. *Current Anthropology*, *26*, 131–133.

Kaplan, H., & Hill, K. (1985b). Food sharing among Ache foragers: tests of explanatory hypotheses. *Current Anthropology*, *26*, 223–239.

Kristiansen, C. M. (1990). The role of values in the relation between gender and health behaviour. *Social Behaviour*, *5*, 127–133.

Levin, I. P., Snyder, M. A., & Chapman, D. P. (1988). The interaction of experiential and situational factors and gender in a simulated risky decision-making task. *Journal of Psychology*, *122*, 173–181.

Levy, H., Elron, E., & Cohen, A. (1999). *Gender differences in risk taking and investment behavior: an experimental analysis*. Unpublished manuscript, Department of Finance, The Hebrew University.

Lopes, L. L. (1992). Risk perception and the perceived public. In: D. W. Bromley, & K. Segerson (Eds.), *The social response to environmental risk: policy formulations in an age of uncertainty* (pp. 57–74). Boston: Kluwer Academic Publishers.

Low, B. S. (2000). Why sex matters. . Princeton: Princeton University Press.

Lurie, N., Slater, J., McGovern, P., Ekstrum, J., Quam, L., & Margolis, K. (1993). Preventive care for women: does the sex of the physician matter? *New England Journal of Medicine*, *329*, 478–482.

MacCrimon, K. R., & Wehrung, D. A. (1986). Taking risks: the management of uncertainty. New York: The Free Press.

Powell, M., & Ansic, D. (1997). Gender differences in risk behaviour in financial decision-making: an experimental analysis. *Journal of Economic Psychology*, *18*, 605–628.

Rietz, T. A., Daly, M., & Wilson, M. (1998). *Sensation and risk seeking: an interdisciplinary study. Psychological, simple gamble, and market measures*. Unpublished Manuscript, Department of Finance, University of Iowa ⟨http://www.biz.uiowa.edu/faculty/trietz/papers/zpaper03.pdf⟩.

Ripa, C. P. L., Hansen, H. S., Mortensen, E. L., Sanders, S. A., & Reinisch, J. M. (2001). A Danish version of the Sensation Seeking Scale and its relation to a broad spectrum of behavioral and psychological characteristics. *Personality and Individual Differences*, *30*, 1371–1386.

Rubin, P., & Paul, C. W. (1979). An evolutionary model of taste for risk. *Economic Inquiry*, *17*, 585–596.

Saha, S., Stettin, G. D., & Redberg, R. F. (1999). Gender and willingness to undergo invasive cardiac procedures. *Journal of General Internal Medicine*, *14*, 122–125.

Schroth, M. L. (1996). Scores on sensation seeking as a predictor of sexual activities among homosexuals. *Perceptual and Motor Skills*, *82*, 657–658.

Schulman, K. A., Berlin, J. A., Harless, W., Kerner, J. F., Sistrunk, S., Gersh, B. J., Dube, R., Taleghani, C. K., Burke, J. E., Williams, S., Eisenberg, J. M., Escarce, J., & Ayers, W. (1999). The effects of race and sex on physicians' recommendations for cardiac catheterization. *New England Journal of Medicine*, *340*, 618–626.

Slovic, P. (1999). Trust, emotion, sex, politics, and science: surveying the risk-assessment battlefield. *Risk Analysis*, *19*, 689–701.

Smith, E. A., & Bliege Bird, R. L. (2000). Turtle hunting and tombstone opening: public generosity as costly signaling. *Evolution and Human Behavior*, *21*, 245–261.

Smith, V. K. (1992). Environmental risk perception and valuation: conventional versus prospective reference theory. In: D. W. Bromley, & K. Segerson (Eds.), *The social response to environmental risk: policy formulations in an age of uncertainty* (pp. 23–56). Boston: Kluwer Academic Publishers.

Spigner, C., Hawkins, W., & Lorens, W. (1993). Gender differences in perception of risk associated with alcohol and drug use among college students. *Women and Health*, *20*, 87–97.

Swanson, J. M., Dibble, S. L., & Trocki, K. (1995). A description of the gender differences in risk behaviors in young adults with genital herpes. *Public Health Nursing*, *12*, 99–108.

Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: a reference-dependent model. *Quarterly Journal of Economics*, *106*, 1039–1061.

Vesterlund, L. (1997). *The effects of risk aversion on job matching: can differences in risk aversion explain the wage gap?* Unpublished manuscript, Department of Economics, University of Pittsburgh.

Wang, P. (1994). Brokers still treat men better than women. *Money*, *23*, 108–110.

Wilson, M., & Daly, M. (1985). Competitiveness, risk taking and violence: the young male syndrome. *Ethology and Sociobiology*, *6*, 59–73.

Zuckerman, M. (1979). Sensation seeking: beyond the optimal level of arousal. New York: Wiley.

Zuckerman, M. (1994). Behavioral expressions and biosocial bases of sensation seeking. Cambridge: Cambridge University Press.