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Risk, Reward, and Economic Decision Making in Aging

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Objectives. Older adults' decision quality is considered to be worse than that of younger adults. This age-related difference is often attributed to reductions in risk tolerance. Little is known about the circumstances that affect older adults' decisions and whether risk attitudes directly influence economic decisions. We measure the influence of risk attitudes on age-related differences in decision making in both nonsocial and social contexts.

Methods. Risk attitudes and economic decision making were measured in 30 healthy older adults and 29 healthy younger adults.

Results. Older adults report being less impulsive, sensation seeking and risk tolerant than younger adults. Age did not affect a measure of nonsocial economic decision making. Older adults were more likely to reject unfair divisions of money during an economic social-bargaining game and more likely to make equitable divisions of money during social-giving game. These age-related differences were determined in part by individuals' self-reported risk taking.

Discussion. We conclude that age-related differences in decision making are domain specific and that some social economic decision making is influenced by risk attitudes. Older adults are more risk avoidant, but this does not alter their willingness to wait for reward in a nonsocial context. Perceiving more risk is associated with an unwillingness to accept an unfair offer in social economic contexts and ultimately leads to poorer outcomes for older adults.

Key Words: Aging—Decision making—Delay discounting—Dictator game—Risk taking—Ultimatum game.

THE limited research available suggests that older adults' choices are often of worse quality as compared with younger adults, even when controlling for confounding factors such as income (Agarwal, Driscoll, Gabaix, & Laibson, 2007; Korniotis & Kumar, 2011). Age-related differences in decision making may be due to a decrease in older adults' risk tolerance. In general, older adults report less impulsivity (Patton, Stanford, & Barratt, 1995; Spinella, 2007; Stanford et al., 2009), and not surprisingly, they seek fewer physical and social risks as compared with younger adults (Zuckerman, 1979). Risk-avoidant behavior in older adults is often used to explain why they tend to make conservative decisions about major life events (Mather, 2006; Okun, 1976) and when investing money (Kumar, 2007). Other studies suggest that risk does not affect older adults' decisions, such as choices during risky card games (Dror, Katona, & Mungur, 1998; Kovalchik, Camerer, Grether, Plott, & Allman, 2005), when outcomes are probabilistic as opposed to determined (Deakin, Aitken, Robbins, & Sahakian, 2004) or when cognitive factors are considered (Henninger, Madden, & Huettel, 2010). Taken together, these studies suggest that the relationship between aging and decision making may be mediated, in part, by self-assessment of risk. However, what remains unclear are the particular circumstances in which risk affects economic decision making in older adults.

Experimental laboratory studies of economic decision making examine how decisions are modified when reward, time, or social contingencies vary. Delay discounting is a nonsocial task that involves estimating the subjective value of a monetary reward by identifying the amount at which an individual is indifferent between a smaller, immediate amount of money and a larger amount of money that is received only after a delay (Mitchell & Wilson, 2010). This type of decision making is related to impulsive behavior (Mitchell, 1999), but not necessarily to self-reports of impulsivity in younger adults (McLeish & Oxoby, 2007). It is unknown how age-related changes in self-reported impulsivity and risk affect discounting. Older adults do not differ in the amount they discount a reward (Read & Read, 2004), particularly when age groups are matched for socioeconomic status (Green, Myerson, Lichtman, Rosen, & Fry, 1996). In contrast, early studies found that older adults discount delayed monetary rewards less than younger adults when socioeconomic factors were not considered (Green, Fry, & Myerson, 1994; Harrison, Lau, & Williams, 2002). Waiting for the 'best' possible outcome is a beneficial strategy; however, this may not apply to older adults as they have limited future time horizons (Carstensen, 2006). Therefore, we believe that older adults will have equivalent responses as younger adults to delayed rewards, as others have shown, despite their risk aversion.

The context of social interactions affects economic decisions (Rilling, King-Casas, & Sanfey, 2008). Measures of social economic decision making, such as giving money to another person or trusting that others will be fair when asked to share a sum of money, are captured in decision

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Table 1. Participant Characteristics

	N	Sex (Male/Female)	Age (years)	Education (years)	MMSE	WAIS-R	Income (U.S. dollars in thousands)
Younger	29	15/14	30.14 (5.53)**	15.00 (2.80)	—	11.86 (2.64)	27K (13K)
Older	30	15/15	71.30 (4.36)	15.00 (3.60)	28.97 (1.03)	12.53 (2.66)	38K (13K)**

Notes. MMSE = Mini-Mental Status Examination (Folstein et al., 1975); WAIS-R = Weschler Adult Intelligent Scale-Vocabulary subtest (Weschler, 1981); K = thousand; mean (*SD*).

** $p < .01$.

tasks like the Ultimatum game (Guth, Schmittberger, & Schwarz, 1982) and Dictator game (Forsythe, Horowitz, Savin, & Sefton, 1994), neither of which have been used to examine decision making in older adults. The Ultimatum game is a bargaining game that measures views about social economic choice by having two individuals interact to determine how to share a sum of money (e.g., $10). In contrast, in the Dictator game, a participant presents an anonymous stranger with a one-time monetary offer. If people were purely self-interested, they should accept any nonzero Ultimatum game offer or keep the entire sum of money in the Dictator game. Instead, younger adults will forgo a small financial reward in the Ultimatum game (e.g., $1) if they feel they are being treated unfairly by another person (e.g., the person keeps $9 for themselves; Eckel & Grossman, 1996). In the Dictator game, people typically make equitable offers instead of keeping the entire sum of money for themselves (Camerer, 2003). Like nonsocial economic tasks, these games not only provide a measure of the value participants assign to alternatives but also provide information about the effects of interacting with another person during a decision (Rilling et al., 2008). Older adults prefer social interactions with individuals they know rather than strangers moreso than younger adults (Fredrickson & Carstensen, 1990) and tend to avoid making decisions when solving social problems (Blanchard-Fields, Mienaltowski, & Seay, 2007). Thus, risk aversion (i.e., less risk taking) may directly affect older adults' choices in economic decisions that involve social interaction, but this has not been studied.

The goal of this study was to determine whether self-reports of risk are related to behavior on economic decision tasks where rewards vary based on time or interactions with others. We hypothesized that aging is associated with more conservative self-reports of behavior (i.e., being less impulsive, and taking fewer risks) and that risk attitudes affect performance on decision-making tasks. Specifically, we hypothesized that older adults would be more conservative and less trusting and thus would be more likely to accept low offers and give less to others than younger adults on social economic decision tasks but will show equivalent nonsocial decision making. However, these age-associated differences in economic decision making will not be found when self-reports of impulsivity and risk taking are taken into consideration, suggesting that age-associated differences in risk attitudes drive older adults' economic decisions. To test this hypothesis, we compare and contrast the responses of healthy younger and older adults on traditional measures of self-reported impulsivity (Barratt Impulsiveness Scale; Barratt, 1959), sensation seeking (Zuckerman, Kolin, Price, & Zoob, 1964), and risk taking (Domain-Specific Risk Taking [DOSPERT]) and relate responses on these measures to experimental measures of nonsocial (delay discounting) and social (Ultimatum and Dictator games) economic decision making.

Method

Participants

Participants were 30 healthy older adults (65–85 years) and 29 healthy younger adults (21–45 years) recruited from an urban population (Table 1). We recruited participants that had experienced relatively comparable lifestyles including education attainment and health status. However, current or pre-retirement income, as measured through a self-report questionnaire, was not normally distributed. Older adults reported significantly more income than younger adults, Mann–Whitney U, $Z = -2.80$, $p = .005$; thus, income was used as a covariate in analysis. Participants understood English and had adequate hearing and vision to comprehend the tasks. There were no age differences on the vocabulary subtest of the Wechsler Adult Intelligence Scale—Revised (WAIS-R; Wechsler, 1981). This subtest provides a standardized approximation of functional intelligence and is highly correlated with full-scale IQ. Matching groups on this variable helps to control for the fact that the formal educational environment may have differed between age groups. When there is missing data on a task, such as due to computer error, the number of participants that completed the task is stated. The resulting older and younger groups were still matched for education and WAIS-R Vocabulary.

Health histories were obtained by phone. Participants were excluded for self-reported history of neurological problems (e.g., stroke, seizure, or head trauma), medical problems (e.g., uncontrolled hypertension), current or previous psychiatric conditions (e.g., schizophrenia), or current use of medications likely to affect mood or cognition (e.g., anti-anxiety agents). The Mini-Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975) and Geriatric Depression Scale (GDS; Sheikh, Yesavage, Brooks, Friedman, & Gratzinger, 1991) were used as screening measures to exclude older participants with possible dementia (MMSE < 26) or depression (GDS > 10). No older participants had abnormal MMSE or GDS scores. The

Oregon Health & Science University Institutional Review Board approved this study and all participants provided written informed consent.

Self-Report Measures

We used paper-and-pencil, self-report questionnaires of impulsivity, sensation seeking, and risk taking to examine age-related differences in these factors and whether differences influence decision making. Data are missing on these self-report measures for one younger adult.

The Barratt Impulsiveness Scale (Barratt, 1959; Patton et al., 1995) indicates how people act and think across 30 different situations using a 4-point scale from rarely/never to almost always/always (Patton et al., 1995). The total score, derived from three subscales (attentional impulsivity, motor impulsivity, and nonplanning impulsivity), was the main outcome measure.

The Sensation Seeking Scale Form V was used to measure the tendency to seek out intense sensory experiences (Zuckerman et al., 1964). The total score, composed of the scores from subscales that measure experience seeking, thrill seeking, disinhibition, and boredom susceptibility, was used as the main outcome measure.

The DOSPERT scale is used to assess self-reported risk taking and perceived risk of an activity. The scale has been validated, and its factor structure replicated in a wide range of settings and populations (Blais & Weber, 2006), but to our knowledge, it has not been used to compare risk taking in younger versus older adults. It contains five decision domains as subscales: (a) ethical, (b) financial, (c) health/safety, (d) social, and (e) recreational (Weber, Blais, & Betz, 2002). Total risk taking and risk perception scores were used as main outcome measures. Decision domains were used as exploratory measures.

Economic Decision Making

Delay discounting.—The delay-discounting task used was similar to prior studies (Herting, Schwartz, Mitchell, & Nagel, 2010; Mitchell, 1999). Participants were presented with questions one at a time on a computer screen and indicated which of two choices they preferred: delayed or nearly immediate money. The delayed money was $10.00 available after one of six delays (1, 7, 30, 90, 180, or 365 days; see Figure 1A). The "nearly immediate" money ranged from $0.00 to $10.50 in $0.50 increments and was available the next day. Each subject saw all possible combinations of delay and amount over 138 questions, which were presented in random order. Participants indicated their preference with a mouse button press. We did not use a truly immediate option as other studies have shown that immediate, in hand rewards are over-weighted due to a certainty effect (Hertwig & Ortmann, 2001; Kahneman & Tversky, 1979) and may overly engage emotional processing (McClure, Ericson, Laibson, Loewenstein, & Cohen, 2007). Data are not available on five older subjects on this task. The main outcome measure was the average indifference point. The indifference point is the value at which a participants' preference switches between the nearly immediate and delayed reward (Rachlin, Raineri, & Cross, 1991). This point was operationally defined as being midway between the smallest value of the nearly immediate alternative accepted and the largest value that was rejected (Mitchell, 1999). A hyperbolic equation was fitted to each participant's indifference point using the Solver subroutine in Microsoft Excel 2007:

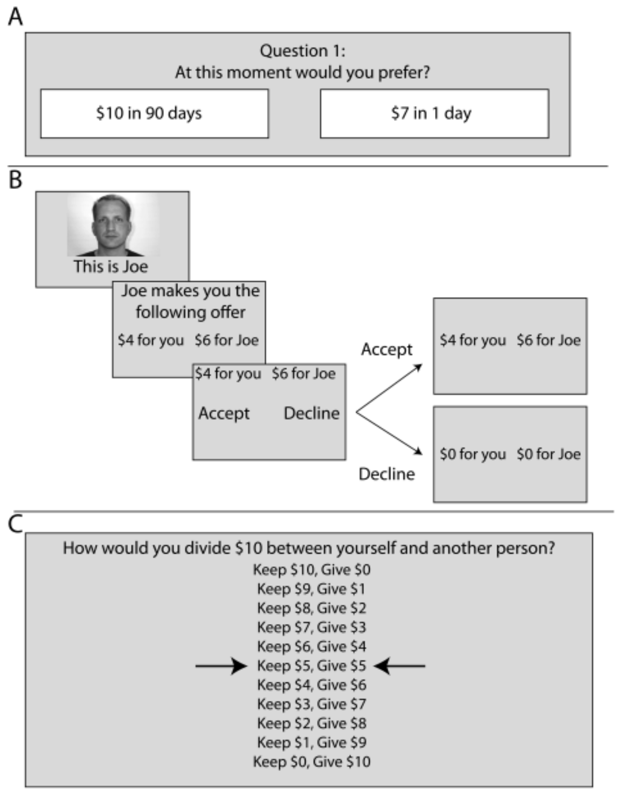

Figure 1. Example trials for three decision-making tasks: (A) The delay-discounting task, (B*) the Ultimatum game, and (C) the Dictator game. *Photographs courtesy of the Center for Vital Longevity at the University of Texas at Dallas (Minear & Park, 2004).

$$V = M/1 + kD, \quad (1)$$

where V represents the value of the delayed item indexed by the indifference point, M represents the amount of money available from the delayed alternative item (e.g., $10.00), D represents the length of the delay, and k is a fitted parameter indexing the rate of discounting with lower indifference points indicating less tolerance for delayed monetary rewards (i.e., more preference for the immediate reward; Ainslie, 1992). Goodness of fit (R^2) for the hyperbolic function and area under the curve (AUC) were also used as secondary outcomes (Myerson, Green, & Warusawitharana, 2001).

Ultimatum game.—In this game, the proposer (computer) proposes a split of $10 that is either accepted or rejected by the participant (Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). If the proposal is accepted, the money is shared accordingly; if rejected, neither player gets any money. Participants played the game with 50 novel computer-generated proposers who were depicted by a name and photograph (Minear & Park, 2004). Participants were told that responses with one proposer would not affect subsequent interactions. All participants saw the same set of offers. Ten dollars was proportionally divided on every trial (e.g., "Joe keeps $8" and "You receive $2"). Twenty percent of offers were split evenly ($5:$5), 60% of offers were moderately unequal splits ($6:$4, $7:$3), and 20% of offers were extremely unequal splits ($8:$2, $9:$1). Participants were not offered more than an equal share of the $10 (i.e., generous). Participants were shown one of each offer type during a practice session to ensure they understood the task. Three outcome measures were used: (a) average acceptance rates (% offers accepted) for the five offer types ($5, $4, $3, $2, $1), (b) median response times to accept or reject offers, and (c) average amount accepted over all offers.

Dictator game.—The Dictator game used was similar to previous studies (Bolton, Katok, & Zwick, 1998). Participants played one round of the Dictator game in the role of proposer. They decided how much of a $10 endowment to keep for themselves and how much to give an unknown partner. No picture of the partner was displayed (Figure 1C). All possible whole-dollar combinations by which $10 could be divided were presented to each participant on a computer screen. Participants selected one option (e.g., $5 for you and $5 for the other person) using a computer keyboard. By default, the 'fair' option was highlighted in the center, so that the same number of button presses would select the most generous offer or the most greedy offer. Two outcome measures were used: The average amount offered by participants and a categorization of participants based upon their individual offer as "fair" (keeping $5 and giving away $5) or "greedy" (keeping more than half of $10). Because only two subjects made a generous offer (keeping less than half of $10), we did not examine this category further. Data for three older adults were lost due to computer error.

Task order.—All tasks were completed during one session. The self-report measures were presented in a randomized, counterbalanced order prior to the economic decision-making tasks. The Ultimatum game always preceded the Dictator game with delay discounting randomly presented before or after the other two economic tasks. The experimenter left the room during the self-report measures and the economic decision-making games so that the participant made choices freely without being observed (Forsythe et al., 1994; Hoffman, McCabe, Shachat, & Smith, 1994). All participants were read standardized instructions prior to completing each task (Supplementary Methods).

Payment procedure.—Participants were paid $10 in cash for participation. Participants were reminded they were playing for actual money before beginning each economic task and were informed of their total earnings at the completion of the test session. To make the economic and risk nature of the tasks realistic, participants were informed that additional compensation could be earned based on their performance. At the conclusion of the test session, one trial from each task was randomly selected and that outcome was paid. For example, if the randomly chosen trials were $10 in 30 days in delay discounting, an accepted offer of $4 in the Ultimatum game and a decision to keep $5 in the Dictator game, a total of $19.00 was mailed to the participant in 30 days.

Data Analysis

Separate independent-sample *t* tests were used to test age effects on total scores of the Barratt Impulsiveness, Sensation Seeking, and DOSPERT scales. A mixed-model repeated-measures analysis of variance (ANOVA) with delay as a within-subjects factor and age as a between-subjects factor was used to examine delay discounting. In addition, independent-samples *t* tests were used to compare age effects on log-transformed *k* values (i.e., rate of discounting) and the goodness of fit for the hyperbolic delayed function and area-under the discounting curve. A 2 × 5 (Group × Offer) mixed-model repeated measures ANOVA was used to examine the Ultimatum game responses. Independent samples *t* tests were used to compare age groups on the time it took to accept or reject offers and on the average amount accepted over all offers. A *t* test comparing the average offer between groups and a chi-square of the number of individuals in each group that were either fair or greedy was used to assess Dictator game performance.

To assess the relationship between age, self-report measures, and economic decision making, a multiple regression analysis was used. Because the questionnaire measures tend to be correlated with each other, we chose the self-report measure that was most related with performance on a given economic task (as indicated in Table 4). Average self-report scores and age were used as predictors of average total score for a given economic task. Change statistics were calculated for multiple regression models.

For all analyses, homogeneity of variance was confirmed using Levene's test, and values below $p = .10$ were considered significant violations and are noted in the text. Original degrees of freedom are shown with corrected *p* values. The two-tailed significance threshold was alpha = .05 with Bonferroni corrections for multiple comparisons where needed. Where sphericity could not be assumed, a Greenhouse–Geisser correction was used to adjust *p* values. Where comparisons are discussed, the numbers shown are means ± standard deviation.

Table 2. Total and Subscale Self-Report Scores for Younger and Older Adults

	Younger	Older	Comparison	*t* Value	*p* Value
BIS					
Total	64.42 (9.93)	59.30 (8.11)	Y > O	2.16	.04*
Attentional	15.82 (4.06)	14.40 (3.19)	Y = O	1.49	.14
Motor	24.11 (3.84)	21.97 (3.85)	Y > O	2.12	.04*
Nonplanning	24.50 (3.93)	22.93 (2.84)	Y = O	1.73[a]	.09
SSS					
Total	23.14 (7.06)	14.10 (7.61)	Y > O	4.68	<.01*
Disinhibition	5.39 (2.81)	2.77 (2.60)	Y > O	3.70	<.01*
Thrill/Adv.	7.29 (2.73)	4.50 (2.81)	Y > O	3.80	<.01*
Experience	7.29 (1.99)	4.83 (2.37)	Y > O	4.33	<.01*
Boredom Sus.	3.07 (1.80)	2.00 (2.02)	Y > O	2.03	.04*
DOSPERT risk taking					
Total	107.89 (22.79)	79.80 (22.71)	Y > O	4.69	<.01*
Financial	17.07 (7.66)	14.60 (6.94)	Y = O	1.29	.20
Health/safety	21.36 (7.13)	13.00 (7.26)	Y > O	4.42	<.01*
Recreation	26.75 (9.61)	14.57 (8.51)	Y > O	5.12	<.01*
Social	29.43 (3.84)	26.67 (4.44)	Y > O	2.53	.01*
Ethical	13.29 (4.76)	10.97 (4.53)	Y = O	1.89	.06
DOSPERT risk perception					
Total	115.10 (21.62)	143.20 (17.99)	Y < O	5.39	<.01*
Financial	28.32 (7.49)	33.83 (3.89)	Y < O	3.55	<.01*
Health/safety	25.75 (5.75)	34.23 (5.14)	Y < O	5.93	<.01*
Recreation	21.82 (6.07)	31.07 (7.24)	Y < O	5.26	<.01*
Social	12.43 (5.61)	12.67 (4.34)	Y = O	0.18	.85
Ethical	26.79 (7.05)	31.40 (5.26)	Y < O	2.83	.04*

Notes. Y = younger adults; O = older adults; BIS = Barratt Impulsiveness Scale; SSS = Sensation Seeking Scale; Thrill/Adv. = Thrill and Adventure; Boredom Sus. = boredom susceptibility; DOSPERT = Domain-Specific Risk-Taking Scale; mean (*SD*).

[a] Equal variances not assumed.

*Significant difference.

Results

Self-Report Measures

Younger participants reported higher levels of impulsive behavior as compared with older adults. (Table 2). They reported greater motor impulsiveness and marginally greater nonplanning impulsiveness but equivalent attentional impulsivity as compared with older adults. The younger adults had higher total and higher subscale scores for sensation seeking (Table 2) as compared with older adults. In general, younger adults reported higher levels of risk taking and lower levels of risk perception on the DOSPERT (Table 2). Exploratory analysis of each domain showed that younger adults reported higher risk taking on health/safety, recreation, and social behaviors but do not differ from older adults on Financial or Ethical situations. In addition, younger adults reported less risk perception than older adults in financial, health/safety, recreation, and ethical situations, but not social situations (Table 2).

Economic Decision-Making Tasks

Age did not affect the average indifference point on delay discounting, $F(1,53) = 1.47$, $p = .23$, (Table 3). Indifference points decreased as delay interval increased, $F(5,265) = 101.66$, $p < .001$. There was not a significant interaction between delay and age group, $F(5,265) = 2.16$, $p = .12$. However, because one previous report found that with increasing age there is more sensitivity to long delays (Green, Fry, & Myerson, 1994), we explored indifference points at each delay interval (*t* tests). Older adults were less willing to wait for a monetary reward at the longest delay interval, $t(52) = 2.14$, $p = .04$, but not at any other interval; however, this difference did not survive multiple comparison correction. Results remained the same when individuals (three younger and one older) that exhibited nonsystematic discounting were removed (Johnson & Bickel, 2008). The fit of the indifference point curves were similar for younger and older adults, Wilcoxon W = 723.5, $Z = 1.49$, $p = .14$, and there was no age-group difference in the AUC measure, $t(53) = .14$, $p = .17$. All results remained the same when adjusted for income.

Table 3. Measures of Discounting

	1 Day	7 Days	30 Days	90 Days	180 Days	365 Days	*k* Value	R^2	AUC
Younger	9.98 (0.09)	8.70 (1.32)	7.51 (2.42)	6.56 (2.88)	6.07 (3.04)	5.22* (2.94)	0.01 (0.03)	0.76 (0.25)	0.63 (0.27)
Older	10.03 (0.15)	8.46 (1.55)	7.22 (2.59)	5.70 (2.99)	4.89 (3.41)	3.74 (3.02)	0.02 (0.04)	0.87 (0.16)	0.53 (0.29)

Notes. R^2 = goodness of fit; AUC = area under the curve (Myerson et al., 2001); mean (*SD*).

**p* = .04, uncorrected.

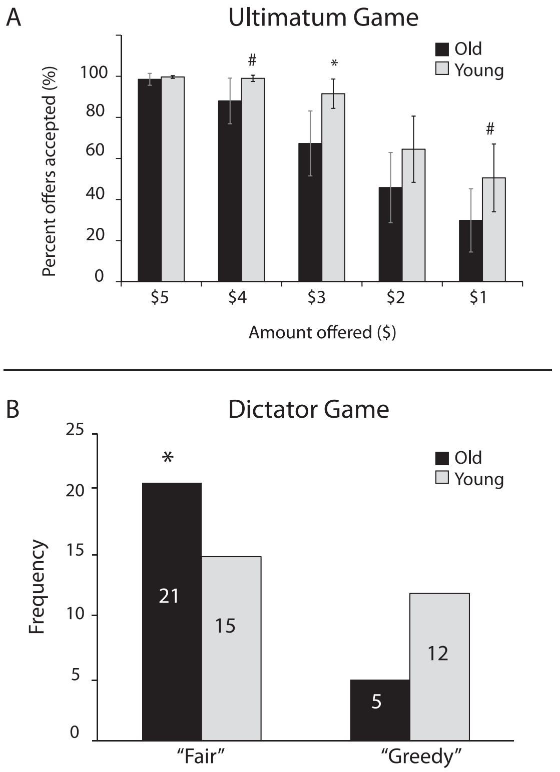

Figure 2. Responses during Ultimatum and Dictator games: (A) mean acceptance rates in the Ultimatum game (mean ± confidence interval). Older adults accept fewer unfair offers as compared with younger adults (*$p < .05$; #$p < .10$). (B) Older adults are more likely to evenly split a sum of money in the Dictator game as compared with younger adults. The numbers indicate how many participants fell into each category. The number of individuals classified as generous, fair, or greedy are indicated in the figure (*$p < .05$).

Ultimatum game.—Younger adults accepted more offers than older adults, $F(1,57) = 6.15$, $p = .01$ (Figure 2A), including income as a covariate did not alter these results. There was a main effect of offer amount, $F(4,228) = 49.12$, $p < .01$, and post hoc pairwise comparisons showed that acceptance rates declined based on their divergence from equality ($5:$5 = $4:$6 > $3:$7 > $2:$8 >$1:$9; all *p*'s < .05). The interaction between age and offer amount was not significant, $F(4,228) = 1.64$, $p = .19$. It is possible that ceiling effects obscured subtle age effects as virtually all $5/$5 offers (99.07%) were accepted. In exploratory analyses of each unfair offer, older adults were more likely to reject $3 offers, $t(57) = 2.74$; $p < .03$, and were marginally more likely to reject all other unfair offers: $4 offers, $t(57) = 1.92$, $p = .06$; $2, $t(57) = 1.55$, $p = .13$; and $1, $t(57) = 1.79$, $p = .08$ (Figure 2A). There was no age-group difference in median response time across all offer types, $t(57) = 1.09$, $p = .28$. Overall, older adults, $3.91 ± 0.50, required offers to be significantly larger to accept them as compared with younger adults, $3.63 ± 0.26, $t(57) = 2.69$, $p = .01$. In addition, 10 younger and 7 older participants accepted all Ultimatum game offers. Removal of these participants did not change the pattern of results.

Dictator game.—Younger, $4.00 ± 2.51, and older, $4.23 ± 1.70, adults did not differ in the average amount offered in the Dictator game, $t(53) = 0.40$, $p = .70$. When categorizing subjects based on their offers, 15 younger and 21 older were considered "fair," whereas 12 younger and only 5 older were considered "greedy" (Figure 2B). Using Pearson chi-square test, younger adults were just as likely to distribute funds equally as unequally, yet, older adults were more likely to distribute funds equally than unequally, Pearson $\chi^2(1) = 3.87$, $p = .05$.

Relationships among measures.—Overall, the questionnaire measures were correlated with each other and similar patterns were seen within each age group (Table 4). Higher DOSPERT risk taking was positively related with higher sensation seeking. Ultimatum game performance was positively related with sensation seeking and DOSPERT risk taking. Higher offers in the Dictator game were associated with lower self-reported risk taking on the DOSPERT. Delay discounting (*k* values) was not related with questionnaire measures or performance on the Ultimatum or Dictator games. Ultimatum and Dictator game responses were not related.

Finally, multiple linear regression (MLR) analyses were used to determine the relationship between age, self-report measures, and economic decision making (Table 5). Two predictors were entered into each MLR: 1) age (continuous) and 2) the self-report measure that was most related with performance (see Table 4) on a given economic task. Age and DOSPERT risk perception were the predictors for delay discounting; age and DOSPERT risk taking were the predictors for both the Ultimatum game and Dictator game. Neither DOSPERT risk perception nor age predicted delay discounting. In the Ultimatum game, age was not a significant predictor of performance, $\beta = -0.17$, $p = .26$ when controlling for DOSPERT risk taking; however, DOSPERT risk taking was a marginally significant predictor of Ultimatum game acceptance rates, $\beta = 0.25$, $p = .09$ when controlling for age; furthermore, the change in R^2 value was not significant when age was added to the DOPSERT risk taking in the hierarchical regression model (Table 5). Simple linear regressions show that individually, age, $\beta = -0.30$, $p = .02$, and DOSPERT risk taking, $\beta = 0.35$, $p < .01$, were significant predictors of Ultimatum game performance. But, the amount variance explained by age, adjusted $R^2 = .07$, was less than the variance explained by DOSPERT risk taking, adjusted $R^2 = .11$. The pattern of results remains the same when individuals who accepted all offers were removed from the analysis. Neither the DOSPERT risk taking score nor age predicted the average amount given away during the Dictator game.

Discussion

We found that older adults, in general, sought less sensation, were less impulsive and were more risk averse than

Table 4. Correlations of Age and All Decision Scales and Tasks for Young and Old Adults

	BIS	SSS	DOSPERT (risk taking)	DOSPERT (risk perception)	Delay discounting	Ultimatum game	Dictator game
Younger (*n* = 29)							
BIS	—						
SSS	.30	—					
DOSPERT							
Risk taking	.34	.66*	—				
DOSPERT							
Risk perception	−.15	−.24	−.54*	—			
Delay discounting	−.18	.09	.08	.17	—		
Ultimatum game	−.09	.10	.20	.12	.23	—	
Dictator game[a]	.12	−.05	−.12	−.06	−.29	.03	—
Age	−.23	−.29	−.08	−.01	−.02	.21	.19
Older (*n* = 30)							
BIS	—						
SSS	.22	—					
DOSPERT							
Risk taking	.66*	.45*	—				
DOSPERT							
Risk perception	−.04	−.23	−.35	—			
Delay discounting[b]	.24	−.12	.06	.19	—		
Ultimatum game	.27	.22	.23	−.23	.15	—	
Dictator game	−.05	−.17	−.38*	.45*	.14	−.07	—
Age	−.25	.14	−.28	−.07	.18	−.15	.07

Notes. BIS = Barratt Impulsiveness Scale; SSS = Sensation Seeking Scale; DOSPERT = Domain-Specific Risk- Taking Scale. All Pearson correlation coefficients reported are uncorrected. Variables used in correlation analysis: BIS (total score); SSS (total score); DOSPERT (total risk taking and risk perception score); delay discounting (*k* value); Ultimatum game (total % of offers accepted); Dictator game (average amount offered to participant).

[a] Degrees of freedom = 26.

[b] Degrees of freedom = 25.

*$p < .05$ (uncorrected)

younger adults. They did not differ from younger adults in the degree to which delay would discount rewards but they were more likely to reject unfair offers and more likely to split funds equally with another person than were younger adults. In addition, the degree to which participants were risk averse predicted their acceptance rate during social bargaining but was not related to discounting or social giving.

Table 5. Regression Analyses for Economic Decision-Making Tasks

	Model summary				Change statistics			
Task predictors	R^2	*F*	df	*p* Value	R^2	*F*	df	*p* Value
Delay discounting								
1. Age	.05	2.91	1, 54	.09				
2. DOSPERT risk perception	.04	2.15	1, 53	.15				
3. DOSPERT RP + Age	.06	1.65	2, 53	.20	.02	1.13	1,51	.29
Ultimatum game								
1. Age	.09	5.59	1, 58	.02				
2. DOSPERT risk taking	.12	7.78	1, 57	<.01				
3. DOSPERT RT + Age	.14	4.57	2, 57	.02	.02	1.13	1,55	.26
Dictator game								
1. Age	.01	0.41	1, 54	.53				
2. DOSPERT Risk taking	.06	3.08	1, 53	.09				
3. DOSPERT RT + Age	.06	1.55	2, 53	.22	<.01	0.07	1,51	.79

Notes. DOSPERT = Domain-Specific Risk-Taking Scale (Weber et al., 2002); RT = risk taking; RP = risk perception.

Taken together, these results indicate that age effects on risk taking alter older adults social economic decisions.

Our results extend prior findings of older adults' risk aversion and loss of sensation seeking (Roth, Schumacher, & Brahler, 2005; Zuckerman, Eysenck, & Eysenck, 1978) with the DOSPERT data. Specifically, older adults reported taking fewer risks in health/safety, recreation, and social activities and perceived most activities, but not social activities, as more risky than younger adults. The reason for older adults' is risk and sensation averse is unknown. They have accumulated more experience (Zuckerman et al., 1978) and thus may be better at predicting likely outcomes, or it may be that physiological or cognitive changes lead to more conservative behavior (Zuckerman, 1994). Of note, social decisions are the only domain in which older adults report equivalent risk perception but less risk taking than younger adults. Perceiving less risk in social situations may expose older adults to telephone or in-person financial scams, particularly in situations where they are not particularly risk averse.

Our discounting data confirm prior reports that aging does not impact discounting behavior (Steinberg et al., 2009), particularly when income is considered (Green et al., 1996). Older adults show a marginal decrease in discounting at the longest delay. This may be due to their limited future time perspective (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000) or cognitive changes (Henninger et al., 2010; Wood, Busemeyer, Koling, Cox, & Davis, 2005).

Furthermore, we showed that self-reports of impulsivity, sensation seeking, and risk attitudes were not related and did not predict discounting behavior (McLeish & Oxoby, 2007). Unlike previous studies that used hypothetical outcomes (Green, Fristoe, & Myerson, 1994; Read & Read, 2004), we used real outcomes, and some (Edwards, 1953; Slovic, 1969), but not all studies (Reynolds, 2006) find this results in more discounting. It is also possible that older adults are differentially affected when what is being discounted is a substantial amount of money or when weighing multiple incentive values, such as vacation time (Read & Read, 2004). Differences among studies may also be due to age. Our cohort of older adults was older than those in prior studies (Harrison et al., 2002), whereas other studies assessed people in their 50's (Read & Read, 2004). Other studies suggest that age-related disparity in socioeconomic variables, such as income, education, or employment status increase discounting rates more than age (Harrison et al., 2002). Our findings suggest that discounting does not differ when younger and older subjects are well matched on socioeconomic and demographic variables, and it is not directly related to risk attitudes.

We found age-group differences when economic decisions require social interactions. Although most everyone rejects the most unequal offers and accepts equal ones, older adults accept fewer offers, particularly unequal offers ($3/$7) in the Ultimatum game and are more likely to equally share a sum of money in the Dictator game than younger adults. However, performance on these two games is not related, suggesting that they tap different decision processes and have different decision contexts (Eckel & Grossman, 1996; Scheres & Sanfey, 2006). Older adults may be attempting to maintain fairness and have more conservative criteria for fairness than younger adults. Our regression analyses suggest this is due in part to risk aversion as DOSPERT risk taking explained more of the variance in Ultimatum game performance than age. Are the effects due to financial or social risk aversion? Older adults tend to avoid financially risky decisions (Kumar, 2007); however, in the Ultimatum game the payout is guaranteed. Alternatively, older adults may view unfair offers as socially risky, possibly rejecting them because they are socially disgusting. Older adults were more likely to give more money away during the social exchange and thus reduced their own reward. This implies that older adults are less willing to disrupt social interactions with self-interested choices. Furthermore, age-related differences in risk attitude reflect known age-related changes in social preference (Blanchard-Fields et al., 2007; Fredrickson & Carstensen, 1990). Older adults prefer to interact with other people they know (Fredrickson & Carstensen, 1990) and use decision avoidant strategies when solving interpersonal conflict (Blanchard-Fields et al., 2007). In fact, the mere presence of another individual, including nonrelatives and strangers, affects economic decision making (Bolton & Ockenfels, 2000; Fehr & Gachter, 2000; Fehr & Fischbacher, 2003; Fehr & Schmidt, 1999; Sanfey et al., 2003; Van Lange, 1999). We suggest that age-related changes in decision making are task and context dependent (Dror et al., 1998; Mather, 2006), as we find age-related changes on one social economic decision making task but not on another and not on a nonsocial task. Taken together, our data suggest that risk attitudes, particularly in older adults, influence economic decisions that involve social interaction.

Our conclusions are tempered by a few limitations. The number of individuals tested was larger than many previous studies, yet the sample size is still modest. Given that the effect sizes of age were small, more focused studies on larger samples of older adults are needed to fully elucidate the differences we report. In addition, we acknowledge that a number of the measures included in this study (e.g., DOSPERT) were not designed for use in older populations and comparable measures need to be developed for older populations. However, given the dearth of research in economic decision making and aging, we felt that examining old adults' risk perceptions with this standard measures was justified. Future studies that restrict decision strategies or use debriefing will be useful to learn the strategic or cognitive underpinnings of older adults' choices. Also, it remains unknown how aging affects social expectations (Sanfey, 2009), social norms, or motivation toward small amounts of money (Brown & Ridderinkhoff, 2009); however, we attempted to control for this offering real monetary rewards. Moreover, decisions in the Ultimatum game could affect subsequent playing of the Dictator game, although studies and our data suggest that the strategies used during these two games is quite different (Hoffman et al., 1994). Although we cannot disentangle whether task order affected these results, younger and older adults completed the Ultimatum and Dictator games in the same order and were not directed to use a preferential strategy, so it is unlikely that order affected our results.

In conclusion, our study highlights age differences in specific domains of self-reported risk taking and risk perception and shows that risk attitudes affect some social economic decisions. Lower risk taking translates into changes in social economic decision making that result in older adults forgoing potential rewards, but risk taking does not account for decisions on a nonsocial economic task. There are many other aspects of decision making that we did not examine. For example, future studies that directly manipulate risk, measure decision making in high or low risk-taking older adults, or determine how cognitive burden affects risk taking during social economic decisions would add valuable insights into the underlying mechanism of decision making in older adults. It is critical that we understand the factors that affect older adults' decision making as both the wealth accumulation (Bosworth & Smart, 2009) and long-term care needs (Walker, 2002) of older American continue to grow. We hope that the data presented here will lead to a better understanding of older adults' decisions and begin to shape the way critical information is presented to older adults during important economic decisions.

Supplementary Material

Supplementary Methods can be found at: http://psychsocgeronotology.oxfordjournals.org/

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Conflict of Interest

The authors certify that they have no actual or potential conflicts of interest including any financial, personal, or other relationships with other people or organizations within 3 years of beginning the work submitted that could inappropriately influence our work.

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