Behavioral Biases in Annuity Choice: An Experiment*

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1 Introduction

By moving funds in a population from those states in which the marginal utility of consumption is zero (i.e., after death) to those states in which it is high (i.e., toward the end of a long retirement), the perfect-world case for annuitization of retirement assets is strong. Despite this perfect-world case, annuitization rates for retirement assets are low. Rational explanations (i.e., the difference between the assumptions in the "perfect" world and the real world) for low annuitization rates have been considered. While this literature has produced some "important insights" (Brown 2007, p. 3), many believe that even the summation of these insights still leaves an annuitization gap.

The remaining gap admits the possibility that behavioral biases decrease the attractiveness of annuities. There is a growing body of evidence that suggests behavioral biases significantly affect individual behavior. Biases such as loss aversion, mental accounting and those arising from the frame of reference have been shown to affect saving, investment and other financial decisions, and are suggested to explain anomalies in financial decision-making.[1] Hu and Scott (2007) show that well documented behavioral biases may plausibly contribute to low rates of annuitization by retirees. Recent survey (Brown, Kling, Mullainathan and Wrobel 2008) and experimental (Agnew, Anderson, Gerlach and Szykman 2008) studies find that framing has potentially important effects on consumers' valuation of annuities and may explain, to some extent, why the market for private annuities is much thinner than expected given standard assumptions.

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[1] See Barberis and Thaler (2002), Benartzi and Thaler (1995), and Benartzi and Thaler (2007).

In this study, we systematically investigate the role of biases resulting from a "hit by a bus" concern (i.e., losing one's principal soon after buying the annuity) identified by market surveys and anecdotal evidence.[2] In order to fully understand this concern and assess possible policy responses, we distinguish between two components of the scenario. First, it might be the case consumers are unduly attached to the principal (their endowment). Second, consumers may assign too much weight (more than is warranted given actual probabilities) to the "early" event of dying shortly after annuity purchase. This suggests that "hit by the bus" may represent not just a single bias but potentially a combination of two biases: an endowment bias stemming from loss aversion and a temporal bias stemming from over-weighting early events.

A current market fix for "hit by the bus" is to sell life annuity contracts with guarantees. Guarantees assure payments for a pre-specified length of time and thus provide insurance against the possibility of early death. The majority of life annuity contracts are sold with guarantees. Despite availability of guarantees, the market for private annuities is thin.[3] This may be because guarantees only partially protects the endowment in the case of early death and does not necessarily mitigate over-weighting the probability of an early death.

These biases map well into Kahneman and Tversky's (1979) Prospect Theory of decision making under uncertainty: risk aversion over gains and risk seeking over losses (defined with respect to initial endowments), and an overweighting of small probabilities. Note that when there are two relatively low probability events, such as dying early and dying late, the assumptions upon which the theory is based offers no guidance.

Under standard loss aversion (Kahneman, Knetsch and Thaler 1990), a retiree with a defined contribution (DC) retirement plan would be averse to exchanging the lump sum in her retirement account for a stream of payment because she attaches ownership to this stock of wealth (her endowment). She is willing to forgo some expected gains from annuitization in order to ensure that she does not lose her endowment.[4] It has been suggested that a possible "fix" for endowment biases is to change how DC assets are represented to consumers: instead of specifying balances as a lump sum, specify them as a claim on a stream of payments. Assigning ownership to the stream of payments rather than the lump sum may well deter retirees from taking their retirement assets as a lump sum. We test whether endowment effects are present in the annuity-like decision and whether changing the frame in which endowments are specified affects the annuity choice.

Consumers with a temporal bias would overweight the probability of early outcomes relative to later outcomes. In the case of the annuity decision, although the probability of dying soon after buying an annuity is relatively low, because this event temporally precedes the

[2] In some surveys, a slightly different iteration of the concern is noted: that of dying soon after buying an annuity and losing the principal *to the insurance company*.

[3] Income from private annuities account for no more than 2 percent of total income for retirement age adults. ((Johnson, Burman and Kibes 2004))

[4] One underlying "cause" of an endowment effect is loss aversion. Additional causes include transaction costs and the perceived wisdom of the default. While these alternative explanations may contribute to low levels of annuitization, we do not consider these types of endowment effect in this study.

also relatively low probability event of reduced consumption at later ages, it may well be more salient to consumers. The placing of too much weight on the probability of dying early relative to the probability of living longer than expected increases the perceived riskiness of the annuity.

Many well-documented behaviors are inconsistent with the classical, exponential, discounted-utility model of time preferences. (See Frederick, Loewenstein and O'Donoghue (2002) for an excellent overview.) Time-inconsistent preferences, such as hyperbolic discounting, may surely contribute to the low rate of annuitization. In the wild, it would be difficult to disentangle the effects of over-weighting the *probability* of early events from under-weighting the *utility* of later periods. Our experimental design allows us to focus on the former as payment to experiment subjects occurs at the same time whether "retirement" is long or short.

We stress that we are in no way questioning the rationality of partial annuitization. The availability of social annuities through Social Security payments may reduce the need to fully annuitize retirement assets (Mitchell, Poterba and Warshawsky 1991), particularly among individuals with high income replacement rates from Social Security (Dushi and Webb 2004), those with bequest motives (Friedman and Warshawsky 1990, Ameriks, Caplin, Laufer and Nieuwerburgh 2007), or expectations of large out-of-pocket medical expenses in later life (Sinclair and Smetters 2004, Turra and Mitchell 2004). Marriage may also offer the opportunity to pool risks (Kotlikoff and Spivak 1981), which reduces the attractiveness of private annuities (Brown and Poterba 2000) or at least argues for delaying their purchase (Dushi and Webb 2004). Documented evidence of adverse selection in private annuity markets also explain lower annuitization rates for those with less than average survival probabilities (Mitchell et al. 1991, Finkelstein and Poterba 2004). However, we side with those who find that an annuity puzzle remains even after accounting for these explanations (Davidoff, Brown and Diamond 2005), and therefore find it compelling to consider the ability of behavioral biases to provide a (partial) explanation of this puzzle.

2 Experimental Design

We start by noting an inherent tradeoff faced by a retiree with a rational attachment to maintaining a lump-sum of liquid assets (e.g., a bequest motive): should she die early in her retirement, maintaining a lump sum of assets delivers higher utility due to "bequest value" and (likely) higher consumption utility in those early years.[5] However, should she live many years, the annuity delivers higher overall utility due to increased consumption possibilities in later years.

Absent transaction costs, whether the "rational" retiree is endowed at retirement with the

[5] Although we do not model the utility of the retiree's heirs, we do assume that the retiree incorporates bequest utility in her consumption decision. Therefore, a high weight on bequest utility could lead to consumption lower than the annuity's in all periods.

annuity or with a lump sum of assets is immaterial to evaluating this tradeoff. However, we hypothesize that initial endowments matter in this evaluation. Furthermore, the "rational" retiree does not need the utility paths of the two options in order to make a decision, just the expected utility of each option. However, our hypothesis is that the utility paths do matter in the sense that "early"comparisons are salient.[6]

To test our hypotheses, we design our experiment to capture the salient features of the tradeoff implied by the options. To generate subject payoffs capturing the essence of this tradeoff, we follow the following procedure. First, we calculate the (scaled) utility paths offered by the two options for a representative retiree with a bequest motive in a simplified retirement problem. As the pattern of consumption and bequest utility from the lump-sum option is non-obvious and might engender subject confusion, we construct a "cleaner" outcome rule for this option that closely matches utility path for the retiree. Subjects choose between the annuity and the lump sum. We then determine retirement length via one of 2 transparent procedures, and pay subjects $1 per util realized.

Our treatments vary in two dimensions. In one dimension, we vary endowed asset type. In some sessions we endow subjects with the annuity payout option, in some sessions we endow them with the lump-sum payout option, and in the final set of session we do not endow them with either option. In the second dimension, we vary whether or not risks inherent in the tradeoff are temporally ordered. In one set of sessions, we determine retirement length by sequential survival, thus making clear that the risk of getting hit by a bus shortly after annuitization temporally precedes the risk of low consumption toward the end of a long, non-annuitized, retirement. In a second set of sessions, retirement length is determined by a single draw from a known distribution. We make no mention of "periods." Therfore, the outcomes for which the lump sum dominates the annuity do not precede those in which the reverse is true.

2.1 The Retiree's Asset-Allocation Decision

In the real world, the decision to annuitize retirement wealth (or conversely, to cash out an annuity) is not a binary decision.[7] The real-world retiree may choose to annuitize only a fraction of her retirement wealth and she has some choice in the timing of the annuity purchase.[8] In order to focus on the behavioral aspects of the annuitization decision, we consider the simplest case: at the time of retirement, a retiree must choose either a stock

[6]It is certainly the case that the consumption path is endogenous to expected utility maximization. With curvature of the utility function and declining surviving probabilities, different consumption and, thus utility, paths lead to different levels of expected utility. To illuminate our point more fully, suppose survival probabilities were equal in all periods. Our point is simply that for the expected utility maximizer, it would not matter whether the path of consumption (and thus utility) were upward or downward-slopping whereas it would to an agent with temporal bias.

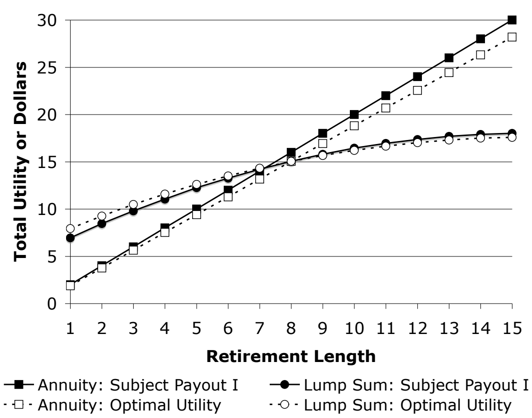
[7]Until recently, most life annuity contracts were irrevocable. Recent contracts, however, are sold with "cash-out" options although these options come at a cost.

[8]Workers with a 401(k)-type retirement plan are constrained by federal rules regarding when they can withdraw assets from the plan. With some exceptions, 401(k) account holders face penalties for early (before age $59\frac{1}{2}$) and late (after age $70\frac{1}{2}$) withdrawals.

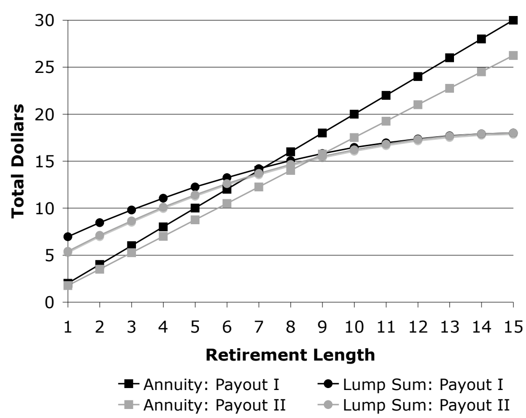
of wealth out of which she can consume or a life annuity.

We make a number of further simplifying assumptions. We assume no inflation, a real interest rate equal to zero, a per-period utility function strictly concave in consumption, and assume that retirement lasts from 1 to 15 periods with each retirement length equilikely. Even in this environment, the decision of whether or not to annuitize is non-trivial. The retiree choosing the option that maximizes expected utility must of course determine the expected utility of each option, which for each option requires optimally choosing per-period consumption subject to the constraints of her asset allocation choice. For simplicity, we assume that the annuitant consumes her entire annuity payment in each retirement period. The optimal path pursuant to non-annuitization requires solving a dynamic optimization problem that will depend on the retiree's utility function.

We assume constant relative risk aversion (CRRA), with $u_t(c_t) = \frac{c_t^{1-\rho}}{1-\rho}$ the per-period utility function of our representative retiree. Our representative retiree enters retirement with a stock of wealth W. A retiree living t periods leaves a bequest $w_t = W - \sum_{\tau=1}^{t} c_\tau$. We assume that the value of a bequest w is $v(w) = \beta\frac{w^{1-\rho}}{1-\rho}$. We set $\rho = \frac{1}{3}$, a reasonable parameter value given previous experimental findings with payoffs of this magnitude (Holt and Laury 2002).[9]



(a) Representative retiree utility vs. Payout I.



(b) Payout I vs. Payout II.

Figure 1: Utility of retiree surviving exactly a given number of periods versus payment to subject surviving exactly a given number of rounds under Payout I (1a). Payment to subject surviving exactly a given number of rounds in Payout I versus Payout II (1b).

In Appendix A, we derive the optimal consumption path for a representative retiree under our assumptions. We show in Figure 1a (dashed lines) the total utility realized for each option by one such retiree living exactly a given number of periods (denoted Retirement Length). After full annuitization, consumption, and thus utility, is the same for each period. If a retiree does not annuitize, her consumption and utility is initially higher than if she had annuitized, but declines in each subsequent period. The utility paths highlight the tradeoff

[9]In fact, $\rho = \frac{1}{3}$ is within the estimated range in bequest simulation models. LW will get Cite.

of interest: annuitization increases expected utility and insures against low consumption in later periods, while maintaining the stock of liquid wealth results in higher utility in the event of a short retirement, in part due to bequest utility unavailable after annuitization.[10]

2.2 Implementation of the Asset-Allocation Decision in the Laboratory

Subjects choose one of two payout options corresponding to an annuity (the Blue Option) and the optimal consumption of a stock of wealth (the Orange Option). We take the scaled per-period utility of a representative retiree for each of these options and offer experimental subjects $1 per util realized. (We do round payoffs for each of the options. See Appendix A for further details.)

As a first step towards establishing the robustness of our results, we consider two sets of payouts. In the subject payouts derived from the representative retiree's utility (Payouts I), the expected payoff from the lump-sum option is 88% of the annuity's. The difference in the maximal payoffs is also rather large ($30 for the annuity and $18 for the lump sum). We design a second set of payoffs (Payouts II) in which the expected payouts of the two options are more equal (lump-sum's expected payout is 97% of the annuity's) and decrease the difference in maximal payoffs ($26.25 versus $18). We do this by making the annuity less actuarially fair (decreasing the per-round payment from $2 to $1.75) while simultaneously decreasing the bequest weight. (See Appendix A for further details.) We show in Figure 1a (solid lines) the overall payment in Payouts I for each option for a subject surviving exactly a given number of rounds (labeled Retirement Length) in those sessions in which subjects did not earn their own endowment. Similarly, Figure 1b compares subjects payments under Payouts I with those under Payouts II.

Note that we do not allow the subject choosing the lump-sum option to actually choose per-period "consumption" from this lump sum. This simplifies the subject's decision problem and allows us to focus on the behavioral hypotheses of interest. Given the complexity of the problem and the limited time to optimize, a subject may make serious mistakes in her allocation. If this subject chooses the annuity, we would not know whether it is because she prefers the annuity's consumption path to the lump sum's or whether she miscalculated the latter's utility possibilities. Further, the subject choosing the annuity would make many fewer decisions than the subject choosing the lump sum. Preferences over number of decision may then be driving decisions.

The Payout Phase (i.e., retirement) lasts from 1 to 15 rounds. A subject receives a "consumption" payment in each Payout-Phase round. We refer to these as **Type-I** payments in the Instructions and in the Payoff Table on the subject's Choice Sheet. As the life annuity under our assumptions pays the same amount in each retirement period, the experiment subject choosing the annuity receives a fixed consumption payment each Payout-Phase round. As we assume a standard concave utility function, the utility path resulting from the opti-

[10] Note that this condition holds even if the retiree derives no utility from bequest. See Davidoff et al. (2005) for additional discussion.

mal consumption of the lump sum declines as periods progress. Therefore, the consumption payment for the subject choosing the lump sum declines with each passing round.

In the Lump-Sum Payout Option, a subject starts with an account.[11] We implement a bequest motive by subtracting "consumption" payments from this account. After a subject's final round, she receives a "bequest" payment equal to a fraction of the amount remaining in her account after her consumption payments have been subtracted. We refer to these as **Type-II** payments in the Instructions and on the Payoff Table. As we assume complete annuitization for the annuity option, the Type-II payments for this option are all equal to zero.

Prior to making a decision, we give each subject a payoff table detailing, for each asset type, Type-I and Type-II payments for each retirement length as well as information about the probability of each length. After making her choice, retirement length is determined by a transparent random process. Retirement lasts up to 15 periods, with each retirement length equilikely.

We note a couple of major differences between a retiree's annuity decision under uncertainty and the experiment subject choosing between payment paths under uncertainty. First, whereas the retiree chooses her optimal consumption path, we present experimental subject with "lump sum" payments generated from the optimal consumption of a representative retiree whose risk preferences may sharply differ from those of the subject. Second, while the "rational" retiree cares only about expected utilities and not their variances, the "rational" subject will care about payment variance unless she is risk neutral. This means that in evaluating the range of potential outcomes, subjects risk aversion affects their choice of outcomes.

We do believe, however, that the behavioral biases will affect both decisions in the same general manner. For example, if changing the frame increases the salience of earlier events, it ought to change decisions whether the payoffs associated with these events are in utils or dollars. Furthermore, we can calculate for each set of subject payoffs the range of risk aversion consistent with the rational choice of the annuity. We measure subject risk aversion, and can therefore measure the effect of our treatments on the likelihood of annuity choice conditional on a subject's level of risk aversion.

2.3 Experimental Treatments

In all sessions, prior to determination of retirement length, a subject chooses a Payout Option: either the Annuity payout option (known to the subject as the Blue option) or the Lump Sum payout option (known to the subject as the Orange option). To test our hypotheses, we implement a 2 $\times$ 3 research design.

[11]In those sessions in which the default option is the Lump-Sum Payout option, we refer to the account as "their" account.

In one dimension, we vary the denomination of retirement assets. In **No Endowment** session, we do not endow subjects with a particular payout option—they are simply asked to choose between the Annuity and Lump-Sum payout options. In the other two sets of sessions, a subject is endowed with either the annuity payout path (**Annuity Endowment**) or the lump-sum payout path (**Lump-Sum Endowment**). We then ask the subject, in essence, whether she would like to trade for the other payout path. However, previous experiments have found that hypothetical endowments are not always sufficient to induce an endowment effect, especially when transaction costs are low.In order to increase attachment to the endowment, we require that subjects earn their beginning assets by performing a timed memory test (the Earnings Phase in the Instructions).[12] Earnings are reported as either an annuity (akin to the Social Security statement we receive each year) or a stock of wealth (akin to the 401(k) statement we receive each quarter). The idea is that subjects will develop a sense of ownership over the *type* of asset when they have to earn the underlying asset. To further foster a sense of ownership, we split the Earnings Phase into two four-minute periods, and report the current and projected per-round payment (in the Annuity Endowment sessions) or account balance (in the Lump-Sum sessions) at the end of each phase. Of course, subjects completing n tasks in either explicit endowment treatment will be offered the exact same payout options.

In the second dimension, we vary how we determine the number of Payout-Phase rounds (i.e., retirement length) and thus how we frame the probabilities and payouts. In the **Simultaneous** sessions, retirement length is determined by a single draw of a lettered chip from a bag. There is no mention of time or rounds. Rather, we identify retirement lengths as Events A, B, . . . , O, with Event A corresponding to a Payout Phase lasting 1 round.[13] There are thus 15 chips in the bag, and each subject chooses a chip that determines the event (i.e., retirement length) that occurs. In the **Sequential** sessions, retirement length is determined by sequential survival. That is, in each Payout-Phase round, the subject draws a marble from a bag of marbles to see if she survives to the next round. If she draws a green marble in round t, she receives the per-round "consumption" (Type-I) payment for round $t + 1$ and then draws another marble to see if she survives to round $t + 2$. If she draws a red marble in round t, her Payout Phase ends and she collects no more per-round payments, but she does receive the round t "bequest" (Type-II) payment if she had chosen the lump-sum option. In the first round, the bag contains 14 green balls, and 1 red ball. In each subsequent round (until she pulls a red ball), the bag contains one fewer green ball than in the preceding round.

Note that there is no difference in either survival probabilities or payoffs across treatments. That is, both Event G in the Simultaneous treatment and surviving exactly 7 periods in a Sequential treatment occur with probability $\frac{1}{15}$ and have the same subject payoff. However,

[12] A subject's monitor displays five letters. After reviewing the letters, she clicks okay and is presented with three letters. The subject must indicate whether all of the three letters were in the original five letters. The subject's score is the number of correctly responses minus the number of incorrect responses.

[13] By listing outcomes associated with an early "death" first, we potentially introduce a bias. This bias ought to work in the same direction as the temporal bias, and thus works against finding a difference in treatments.

in the Sequential treatments, getting hit by the proverbial bus shortly after annuity purchase is the *first* risk she faces, whereas the risk low consumption payments late in the non-annuitized "retirement" is the later risk. If in fact that temporal ordering of risks matters in the manner we hypothesize, we should see lower rates of annuitization in the Sequential treatments.[14]

2.4 Experimental Procedures

No Endowment Sessions

At the start of a No Endowment session, each subject receives a copy of the experiment instructions as well as a Choice Sheet. The experimenter[15] then reads the instructions aloud. These instructions present both payment options without making either a default option. The Choice Sheet for the Sequential sessions presents for each payout option the per-round payment for each round (i.e., the Type-I payment) as well as the additional "bequest" payment a subject receives in the final round (i.e., the Type-II payment, always zero for the annuity payout option). The Choice Sheet for the Simultaneous sessions presents, for each option, the payment for each chip. To make the Choice Sheet for the Simultaneous sessions comparable to those for the Sequential sessions, we split total payment per chip into Type-I and Type-II payments, and instructed subjects that the total payment for a chip was the sum of the two payments. Prior to choosing between payout options, subjects complete a series of review questions. We pay $0.10 for each question correctly answered on the first attempt.[16] We include experiment instructions in Appendix B.1, and the Payout Tables for the No Endowment sessions in Appendix B.3.

Endowment Sessions

We split earned-endowment sessions into two Phases: the Earnings Phase and the Payout Phase. At the start of the Earnings Phase, we distribute initial instructions detailing the endowment generating task and the default payout option without mentioning the other payout option. We also gave subjects with a Points Table indicating for each number of points earned in the Earnings Phase the account balance for Lump-Sum Endowment sessions or the earned per-period payment in the Annuity Endowment sessions. The Earnings Phase consists of two four-minute periods in which subjects are encouraged to earn as many points as possible. The number of points earned is equal to the number of correct responses in the

[14] In our **Sequential** sessions, while we present the probability of surviving to the next period conditional on surviving to the current period, we do not present the unconditional probability of surviving a given number of periods. This means that while a subject in a Simultaneous sessions knows that the probability of Event G is 1/15, a subject in a Sequential session might not know that she has a 1 in 15 chance of surviving exactly 7 periods. While a lower rate of annuitization in Sequential (than in Simultaneous) may be due to early events having more salience, it may also be due to an inability to calculate unconditional probabilities. Therefore, we shall also conduct **Sequential II** sessions, we provide both conditional and unconditional probabilities.

[15] Gazzale in all sessions.

[16] We did not have review questions for the first two sessions. RSG will make sure that there is no difference in theses sessions.

memory task minus the number of incorrect responses.[17] In between periods, a subject's monitor displays the account balance or per-period payment earned after the first period, as well as the account balance or per-period payment the subject would receive if she earns as many points in the second period as she did in the first.

After the Earnings Phase, we offer subjects an alternate payout option: the Annuity Option in the case of the Lump-Sum Endowment sessions and the Lump-Sum option in the case of the Annuity Endowment sessions. We present to each subject a Choice Sheet in which the payoff table is based on the number of points earned in the Earnings Phase. We calibrated earnings such that earning 90 points over the two Earnings periods corresponded to the per-period annuity and account balance in the No Endowment sessions.[18] We also give each student instructions relating to the choice, and then read them aloud. Prior to making the choice of payout options, we present subjects with a series of review questions, paying \$0.10 for each question correctly answered on the first attempt.

All Sessions

After all subjects make the choice of payout option, each student completes a Holt-Laury risk-aversion assessment (Holt and Laury 2002). For each of 10 decisions, a subject chooses between a safe option (in which "Left" pays \$2.00 and "Right" pays \$1.60) and a risky option (in which "Left" pays \$3.85 and "Right" pays \$0.10). The probability of left linearly increases from 1/10 in decision 1 to 10/10 in decision 10. We pay subjects for one decision randomly chosen at the end of the session. Prior to making their choices, the experimenter reads the instructions aloud, and we then present subjects with a series of review questions, paying \$0.10 for each question correctly answered on the first attempt.

When all subjects had made their decisions, we call each student up individually. We first determine retirement length: drawing one chip from a bag in the Simultaneous sessions, and marbles from a bag until a red marble is drawn in the Sequential sessions. We then determined payment for the risk-aversion assessment. Subjects draw two chips with replacement from a bag of ten sequentially numbered chips: the first determines the decision number for which the subject receives payment, the second determine whether left or right occurs. During this time, subjects complete a demographic questionnaire.

We conducted sessions at George Mason University's ICES laboratory in September and October 2008. No more than 15 subjects participated in any session. Two students participated in two sessions. We do not include their second participation in any analysis. Table 1 details the treatments and subject participation in this study. Participants were George Mason University students. Parts of the experiment (the Earnings Phase and the quizzes) were programmed and conducted with z-Tree (Fischbacher 2007). The No Endowment sessions lasted approximately 60–75 minutes, whereas earned-endowment sessions lasted approximately 75–90 minutes. The average payoff was about \$22.70, including a \$7 show-up fee.

[17]We penalize subjects for incorrect responses in order to discourage random guessing.
[18]Further details can be found in Appendix A.

	Simultaneous	Sequential	Total
	27 Payout I	26 Payout I	53 Payout I
No Endowment	28 Payout II	25 Payout II	53 Payout II
	55 Total	**51 Total**	**106 Total**
	26 Payout I	25 Payout I	51 Payout I
Lump Sum Endowment	22 Payout II	24 Payout II	46 Payout II
	48 Total	**49 Total**	**97 Total**
	29 Payout I	28 Payout I	57 Payout I
Annuity Endowment	28 Payout II	25 Payout II	53 Payout II
	57 Total	**53 Total**	**110 Total**
	82 Payout I	79 Payout I	161 Payout I
TOTAL	78 Payout II	74 Payout II	152 Payout II
	160 Total	**153 Total**	**313 Total**

Table 1: Number of subjects in each treatment.

3 Hypotheses

Given uncertainty over outcomes, the unbiased subject chooses the payout option with the greater expected utility. While it is plausible that a *retiree's* per-period utility depends on only per-period consumption, a subject likely evaluates the sum of session earnings. Let x_t^j be the Type-I (consumption) payment and b_t^j be the Type-II (bequest) payment for payout option j in round t. With p_t the probability of surviving to at least round t and d_t the probability of surviving exactly t rounds, expected utility for subject i for payout option j is:

$$\begin{aligned} EU_i^j &= \sum_{t=1}^{15} \left[p_t - p_{t+1}\right] u_i \left(\sum_{\tau=1}^{t} x_\tau^j + b_t^j \right) \\ &= \sum_{t=1}^{15} d_t u_i \left(\sum_{\tau=1}^{t} x_\tau^j + b_t^j \right) \\ &= \sum_{t=1}^{15} d_t u_i \left(y_t^j \right) \end{aligned} \tag{1}$$

where $b_t^{an} = 0$ for all t. Equation 1 expresses the expected utility of an option in terms of the probability a subject's Payout Phase lasts exactly a given number of rounds and the subject's total payment if that is the case. Defining $\Delta_i \equiv \ln(\frac{EU_i^{an}}{EU_i^{ls}})$, a subject chooses the annuity option if $\Delta_i \geq 0$.

We first suppose that following Cumulative Prospect Theory (Tversky and Kahneman 1992), the weights that a subject assigns to different outcomes, $\vec{\delta}$, may deviate from actual probabilities, $\vec{d}$. Given these subjective weights, we define subjective expected utility

$$EU_i^j\left(\vec{\delta}\right) \equiv \sum_{t=1}^{15} \delta_t u_i\left(y_t^j\right). \tag{2}$$

Defining $\Delta_i\left(\vec{\delta}\right) \equiv \ln\left(\frac{EU_i^{an}\left(\vec{\delta}\right)}{EU_i^{ls}\left(\vec{\delta}\right)}\right)$, a subject chooses the annuity option if $\Delta_i\left(\vec{\delta}\right) \geq 0$. In particular, we make the following assumption about decision weights in our treatments.

Assumption 1. *In the Sequential treatments,* $\sum_{\tau=1}^{t} \delta_\tau > \sum_{\tau=1}^{t} d_\tau$ *and* $\sum_{\tau=t}^{15} \delta_\tau < \sum_{\tau=t}^{15} d_\tau$ *for* $0 < t < \bar{t} < 15$*, with* $\sum_{\tau=1}^{15} \delta_\tau = 1$*. In the Simultaneous treatments,* $\vec{\delta} = \vec{d}$*.*

Subject payments for the lump-sum option are greater than those for the annuity option if the Payout Phase lasts fewer than 7 rounds under Payouts I (8 rounds under Payouts II). Therefore, under Assumption 1, it will generically be the case that $\Delta_i\left(\vec{\delta}\right) < \Delta_i$. This leads to the following hypotheses concerning the effect of probability framing.

Hypothesis 1. *For each endowment frame, the proportion of subjects choosing the Annuity (Blue) Payout Option will be greater in the Simultaneous treatment than in the Sequential treatment.*

We next suppose, once again following (Cumulative) Prospect Theory, that a subject evaluates uncertain outcomes relative to her initial endowment: $v(y^j)$. Given this value function, we define subjective expected value conditional on endowment J:

$$EU_i^j\left(\vec{\delta}, J\right) \equiv \sum_{t=1}^{15} \delta_t v_i\left(y_t^j\right). \tag{3}$$

We define $\Delta_i\left(\vec{\delta}, J\right) \equiv \ln\left(\frac{EU_i^{an}\left(\vec{\delta}, J\right)}{EU_i^{ls}\left(\vec{\delta}, J\right)}\right)$, with $J = \{an, ls\}$. Endowed with the annuity option, she keeps the annuity option if $\Delta_i\left(\vec{\delta}, an\right) \geq 0$, and if endowed with the lump-sum option, she does not trade for the annuity if $\Delta_i\left(\vec{\delta}, ls\right) < 0$.

In the spirit of Prospect Theory, we make the following assumption about the value function:

Assumption 2. *Endowed with option* j*, the value function* $v(\cdot)$*:*

- *is convex for* $y_t^{-j} < y_t^j$ *(i.e., over losses relative to endowment);*
- *in concave and equal to* $u(\cdot)$ *for* $y_t^{-j} \geq y_t^j$ *(i.e., over gains relative to endowment);*
- *equal to* $u(\cdot)$ *at* $y_t^{-j} = y_t^j = 0$

Under Assumption 2, it will generically be the case that $\Delta_i\left(\vec{\delta}, an\right) > \Delta_i\left(\vec{\delta}, ls\right)$. This relationship will hold when $\vec{\delta} = \vec{d}$. This leads to the following hypotheses comparing choices when endowed with one of the payout options.

Hypothesis 2. *For each probability frame, the proportion of subjects choosing the Annuity (Blue) Payout Option will be greater in the Annuity Endowment treatment than in the Lump Sum treatment.*

We reiterate that while equation (1) is the appropriate expression for the expected utility of the experiment subject, it is not appropriate for the retiree. Under the assumptions specified in section 2.1 and assuming that bequest utility equals $\beta u(w_t)$ with w_t the period t bequest, expected utility for retiree i for payout option j is

$$EU_i^j = \sum_{t=1}^{15} [p_t - p_{t+1}] \left(\beta u\left(w_t^j\right) + \sum_{\tau=1}^{t} u\left(c_\tau^j\right)\right)$$

with $w_t^{an} = 0$ for all t. Under our assumptions, the rational retiree always chooses to annuitize, although this prediction is highly dependent on the strength of the rational attraction to maintaining a stock of liquid wealth (the bequest motive in our model). We do note that under Assumptions 1 and 2, the hypotheses remain unchanged for a population of retirees drawn from a generic distribution of βs.

4 Results

4.1 Summary Statistics

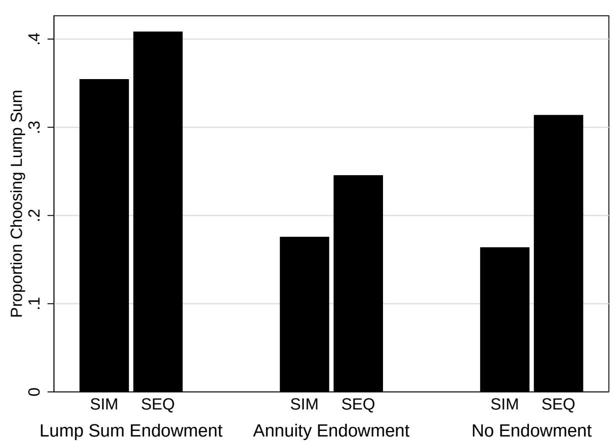


Figure 2: Proportion of subjects choosing lump sum, by treatment.

In Figure 2, we depict for each treatment the proportion of subjects choosing the lump-sum payout option. A few observations are evident from the graphical depiction of our results. First, in all treatments, a significant proportion of subjects chose the annuity payout option. This is not particularly surprising as the annuity is the “rational” choice for most observed levels of risk aversion. Second, our temporal ordering of risks does seem to matter in the hypothesized direction. Regardless of endowment, the proportion of subjects choosing the lump-sum option is greater in the Sequential treatment than in the Simultaneous treatment. Third, Figure 2 suggests an endowment effect, as the proportion of subjects choosing the lump-sum payout option is greatest when we endow subjects with the lump-sum payout option.

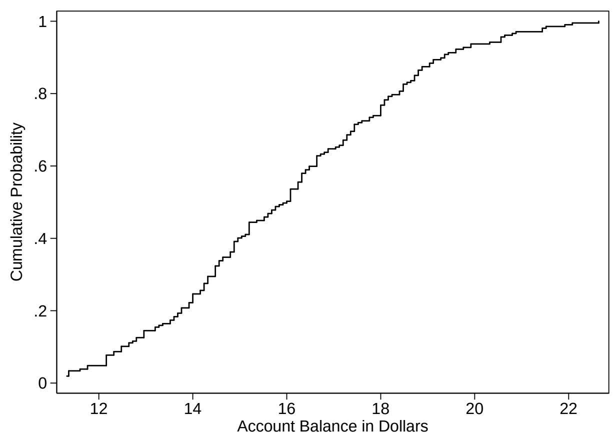


Figure 3: CDF of Earnings Phase outcomes in terms of Account Balance.

In specifying the task in the Earnings Phase and parameterizing the transformation from earned points to Payout Phase payouts, we desired to have a majority of subjects face payoffs levels in line with the No Endowment treatment. We were mostly, but not completely, successful. We show in Figure the cumulative distribution of starting account balances available under the Lump Sum payout option. The starting account balance in the No Endowment sessions was $18, and therefore subjects in these sessions generally brought more wealth into retirement. We do note that 40% of subjects earning retirement wealth were within ±10% of the No Endowment wealth, and 56% were within ±15%.

4.2 Hypothesis Testing

We present in Table 2 the proportion of subjects choosing the annuity payout option by treatment. We also note for each null hypothesis the p-value of the χ^2 test. We now formally test our hypotheses.

Result 1. *The proportion of subjects choosing the Annuity Payout option is greater in the Simultaneous treatment than in the Sequential treatment when subjects are not explicitly*

Endowment	Probability Frame	Annuity Choice Proportion	χ^2 Test H_0	p-value
No Endowment	Simultaneous	83.6%	NoE:Sim=NoE:Seq	0.069
	Sequential	68.6%		
Lump Sum	Simultaneous	64.6%	LS:Sim=LS:Seq	0.584
	Sequential	59.2%	LS:Sim=Ann:Sim	0.037
Annuity	Simultaneous	82.5%	Ann:Sim=Ann:Seq	0.368
	Sequential	75.5%	LS:Seq=Ann:Seq	0.079

Table 2: Annuity choice proportions by treatment and χ^2 test results.

endowed with a payout option. The same difference is not significant when subjects are explicitly endowed with a payout option.

Support: We present in the final column of Table 2 the *p*-values for the χ^2 test of the null hypotheses of equal proportions.

Result 1 suggests that the temporal ordering of risks may well affect decision making. In the No Endowment treatment, we can reject the hypotheses of equal annuity choice at the 10% level of significance. While the proportion choosing the annuity is greater in the Simultaneous treatment in the earned-endowment treatments, we cannot reject the null of equality of proportions given our sample sizes.

Result 2. *The proportion of subjects choosing the Annuity Payout option when endowed with the Annuity Payout option is greater the proportion when endowed with the Lump Sum option regardless of probability frame (Sequential or Simultaneous).*

Support: We present in the final column of Table 2 the *p*-values for the χ^2 test of the null hypotheses of equal proportions.

Result 2 suggests a fairly strong endowment effect in decisions akin to asset allocation in retirement. When there is no temporal ordering of retirement risks (Simultaneous), we reject the null hypotheses of proportion equality at the 5% level of significance, and reject the corresponding null hypotheses at the 10% level of significance when retirement risks are temporally ordered.

5 Empirical Results

The test results presented in section 4.2 provide evidence, albeit not conclusive evidence, that the denomination of initial retirement endowments and the framing of probabilities affect the likelihood of choosing the annuity option. In deriving equation 3, we argued the subjective valuation of an option may depend on the the framing of payouts (i.e., $\vec{\delta} \neq \vec{d}$) as well as the endowed payout option (i.e., $v(\cdot) \neq u(\cdot)$). Outside of treatment effects, valuation explictly depends on a subject's degree of risk aversion as well. Other characteristics may influence payout option choice as well. We alluded to one such possibility earlier (difficulty with probabilities) but there might other, potentially unobserved, characteristics that could just as equally affect the annuity choice. In this section, we attempt to control or remove these other effects in order to more accurately characterize the influence of endowments and temporal risk on the annuity decision.

We characterize annuity choice by an underlying latent process. From Section 3, we define $\Delta_i\left(\vec{\delta}, J\right) = \ln\left(\frac{EU_i^{an}(\vec{\delta},J)}{EU_{ls}^{an}(\vec{\delta},J)}\right)$. The subject chooses the annuity option if $\Delta_i\left(\vec{\delta}, J\right) \geq 0$. Correspondingly, we have

$$Pr(Y_i = 1|X_i, Z_i) = \Phi(\beta_0 + \beta_x X_i + \beta_z Z_i) \tag{4}$$

where X_i denote the set of treatments capturing the assignments of endowments and the framing of probabilities and Z_i denotes a vector of other factors plausibly influencing relative valuation. The vector Z_i includes a measure of risk preferences, the relative expected payouts between the annuity and lump-sum options, and other covariates, such as proxies for cognitive ability, that could affect the annuity decision. The vector of coefficients, β_x, reports our treatment effects is the coefficient vector of interest.

While the controls will parse out the effect of *observable* characteristics from the treatment effect, *unobservable* factors that could influence annuity choice.[19] While these unobserved effects would affect predicted choice probabilities, as long as they do not vary systematically across treatments (i.e., they are uncorrelated with the treatment variables), they would not affect the estimates of the coefficients of interest. As the coefficients of interest (β_x) reflect *changes* in choice probability relative to the omitted case in the probit estimation, any randomly distributed unobserved effect will be "differenced out" in the comparison to the "baseline."[20]

5.1 Data Discussion

Due to missing data, we cannot use all 313 observations in our regression analysis. First, we have missing questionnaire responses. Second, as we discuss below, a number of subjects make "inconsistent" choices on the risk aversion instrument. Our regression sample is the 241 subjects who both responded to all of the questionnaire questions we use to construct regressors and made consistent choices on the risk aversion instrument.

We report in Table 3 a summary of the annuity choices, the risk-aversion assessment, and

[19]For example, a subject may focus only on round 15 Total Payments.

[20]The Sequential sessions may be more confusing that the more straightforward Simultaneous sessions. If true, subjects with lower cognitive ability may be more inclined to use heuristics or rules of thumb in the Sequential treatments, potentially biasing treatment estimates. We attempt to control for this possibility with proxies for cognitive ability.

basic demographic characteristics of the subset of subjects. The demographic characteristics potentially provide information about cognitive ability and we use them, in addition to the measure of risk preferences, as controls in the probit estimation. As many of our potential controls are closely correlated and our sample size is relatively small, we judiciously choose our controls.

Table 3: Descriptive Statistics

		Mean	Std Dev.	$p - values^{(1)}$
Proportion Choose Annuity		0.746		
	with Payouts I	0.805		
	with Payouts II	0.693		0.046
	under Simultaneous	0.805		
	under Sequential	0.679		0.025
	under No Endowment	0.764		
	under Lump-Sum Endowment	0.64		
	under Annuity Endowment	0.817		
Holt Laury Scores		6.638	1.997	
	% in "Prefer Annuity" Range	0.463		
Proportion Choose Annuity				
	Within Range	0.802		
	Outside Range	0.698		0.065
Account Balance		0.927	0.128	
	No Endowment	1	0	NoE-LS: 0.00
	Lump-Sum Endowment	0.879	0.134	NoE-Ann: 0.00
	Annuity Endowment	0.909	0.147	LS-Ann:0.172
Demographic Characteristics				
	Male	0.667		
	Born in the US$^{(2)}$	0.542		
	Age	21.24	2.781	
	Year in School$^{(3)}$	3.45		
	Ever Taken Statistics	0.733		
	Ever Taken Calculus	0.841		
	Time taken to make Choice	-27.92	105.86	
	Total Quiz Earnings	0.828	0.147	
Number of Observations$^{(4)}$		240		

Notes:
(1) p-values for the test that the proportions are similar.
(2) 60% of foreign born are graduate students compared to 6% of US born.
(3) 30% are graduate students, which make up the largest group.
(4) 72 in the No Endowment treatment, 75 in the Lump-Sum treatment and 93 in the Annuity treatment.

5.1.1 Accounting for Risk Preferences

Risk preferences affect the expected value of the annuity relative to that of the lump sum. To ensure that our measured treatment effects are not simply capturing the effect of risk preferences, we include in our specification an index that measures risk preferences.

We elicit an ordinal measure of risk-preferences based on subjects' responses to Holt-Laury (HL) gambles Holt and Laury (2002). As discussed in Section 2, for each of 10 decisions, a subject chooses between a safe option (in which "Left" pays \$2.00 and "Right" pays \$1.60) and a risky option (in which "Left" pays \$3.85 and "Right" pays \$0.10). The probability of left linearly increases from 1/10 in decision 1 to 10/10 in decision 10. Therefore, a "rational" subject who understands the instructions must choose the "risky" option for decision 10 as \$3.85 with certainty must be preferred to \$2.00.

Our measure (the "HL Score") is the first decision number where a subject chooses the risky option. As the probability of a good outcome increases linearly from decision 1 to 10, a consistent subject would switch only once from the safe option to the risky option (or choose the risky option for all decisions). However, nearly 20% of subjects switched back and forth multiple times between the risky and safe option, and a small proportion "irrationally" always chose the safe safe option. Interpretation of these choices is non-obvious. We therefore drop these subjects from our sample.[21]

A subject switching once to the risky option is consistent with a range of risk preferences. For example, a subject fist switching to the risky option at decision 5 in consistent with indifference between the 2 options at decision 4 as well as decision 5. Therefore, under the assumption of CRRA utility, we solve for each HL Score the range of ρ consistent with that choice.

The payout streams in the experiment are constructed such that the expected utility from the annuity stream is at least as good as the expected utility from the lump-sum option *for a range of risk-preferences*. Assuming CRRA utility, the unbiased subject with $\rho \lesssim 0.76$ ought to choose the annuity faced Payouts I, whereas the threshold for the subject facing Payouts II is $\rho \approx 0.27$.

We translate these thresholds into HL Scores by defining $\overline{HL}$: the HL Score whose range of ρ consistent with that choice contains the indifference threshold. Insofar as subjects are expected utility maximizers with CRRA utility, those subjects for whom HL Score$< \overline{HL}$ ought to choose the annuity, whereas those with HL Score$> \overline{HL}$ ought to choose the lump sum. As a particular HL Score is consistent with a range of ρ, we cannot determine the "rational" preference of those subjects for whom HL Score$= \overline{HL}$ For Payouts I, we have $\overline{HL} = 8$, whereas for Payouts II we have $\overline{HL} = 6$.

Nearly 74 percent of subjects chose the annuity option, whereas only 46 percent had HL Score$< \overline{HL}$. In the Simultaneous-No Endowment case, which we take to be the baseline case, the proportions were 85 and 51 percent.[22] As expected, among subjects with scores

[21]To increase our sample size, we retained in our sample 26 observations in which there was only one "stray" choice among a consistent pattern of choices.

[22]Possible explanations for the "discrepancy" even in the baseline case include: difficulty with probabilities; confusion in either or both parts of the experiment; subjective decision weights different than objective probabilities ($\vec{\delta} \neq \vec{d}$) in either or both parts of the experiment; and other unobserved biases. Additionally, CRRA might not appropriately characterize some subjects' preferences.

in the range that should prefer annuity, a higher proportion choose the annuity option than in the counterfactual group (80 percent compared to 70 percent).

This suggests that risk preferences (as measured by HL scores) affect annuity choice. To control for the effect of risk preferences, we include HL scores as a control in the probit estimation. To accommodate the potential kink in the relationship between HL scores and annuity choice at $\overline{HL}$, we allow the slope of the coefficient to differ below and above $\overline{HL}$ through the use of splines. We noted above that $\overline{HL}$ equals either 5 or 7 depending on whether in Payout I or II. We therefore allow the slopes to differ at HL Score=6. (That is, we set the spline node at 6.)[23]

5.1.2 Accounting for Initial Assets

In choosing a parameterized task for the earned-endowment sessions, we sought a distribution of assets tightly distributed around the No Endowment assets. We were only somewhat successful. In the No Endowment treatment, assets correspond to \$18 in an account. Table 3 shows the distribution of account balances by treatment type.[24] Subjects in the Lump-Sum treatment earned less on average than subjects in the Annuity treatment. Furthermore, subjects in earned-endowment treatments started with fewer assets on average than those in the No Endowment treatments. The associated p-values show that these differences are significantly different from zero.

Performance in the memory task measures in some way (a dimension of) cognitive abilities. Approaches to the decision, such as calculating expected value, might thus vary by earned assets and influence annuity choice. Insofar as other observable characteristics do not fully control for cognitive abilities, account balance may provide a useful proxy. We normalize account balances by dividing by the the account balance in the No endowment session (which is \$18) and include this variable, $iAssets$, in the regression specification. The index has a mean of 0.927, a median of 0.982 and there is a clustering at 1.[25]

[23] An alternative is to use a dichotomous variable that is set to 1 if the subject's HL score is up to $\overline{HL}$ and zero, otherwise. We estimated the probit with this specification (not reported in this paper). Results are generally similar although there is a slight loss of precision because of the loss in variation.

[24] We report account balances rather than the annuity's per-round payments as the latter depends on Payout I versus Payout II.

[25] It is important to note that there is no variation in account balance for the No Endowment group. They were each given an account balance of \$18. Whereas, in the Lump-Sum endowment case, on average, subjects in these sessions had account balances that were generally well below \$18 and the number of subjects that are within a narrow band of \$18 was small. Thus, potentially, it may generally be difficult to obtain precision when estimating the Lump-Sum endowment effect with controls for account balance. This would not be an issue when comparing the Lump-Sum and Annuity Endowment sessions because there is sufficient overlap and variation in account balance between these two groups.

5.1.3 Additional Controls

Subjects in all treatments faced one of two sets of payoffs. A main difference between Payouts I and II is that the expected payment for the Lump Sum option is better relative to the Annuity's under Payouts II. This did increase Lump Sum choice across all treatments. We therefore control for Payout set.

In addition to differences in cognitive abilities, Table 3 highlights a fair degree of subject heterogeneity in characteristics that might influence annuity choice. Although the questionnaire provides a number of possible controls, our relatively small sample size warrants parsimony. We include age as a proxy for human capital accumulation. (Most subjects were between the ages 18 and 25.) We also include a dichotomous variable set to 1 if the subject was born in the U.S (isUSborn). (Roughly half of the subjects were foreign born.) This variable captures a number of traits potentially influencing annuity choice. For example, understanding of experiment procedures might vary between foreign and native born subjects.[26] Foreign-born subjects are much more likely to be graduate students (60 percent versus 6 percent). This is particularly important as the majority of graduate students are enrolled in technical programs such as information science and engineering.[27] Our third control for cognitive ability is a dichotomous variable set to 1 if the subject has previously taken a class in Calculus. We dropped 12 observations with missing demographic characteristics, bringing our remaining sample size down to 241.

5.2 Testing Hypothesis One

We hypothesize that framing probabilities as sequential survival causes subjects to overly weight the probability of an early "death" and thus decreases annuity choice likelihood (Hypothesis 1). In this section, we further test the hypothesis, controlling for factors affecting annuity choice that may not have been evenly distributed across treatments. We pool the data from all sessions and estimate:

$$Pr(Y_i = 1) = \beta_0 + \beta_1 LS_i + \beta_2 ANN_i + \beta_3 SEQ_i + \beta_z Z_i + \epsilon_i \tag{5}$$

where LS, ANN and SEQ are treatment dummies set to 1 in sessions with Lump-Sum endowment, Annuity endowment, and Sequential frame, respectively. The baseline (omitted) case, therefore, is the No Endowment Simultaneous treatment. The vector Z_i includes the covariates described above, which are splines for Holt-Laury scores (HL1 and HL2), whether subjected were in session with moreEqual payouts (moreEqual), cognitive ability

[26] Furthermore, we speculate performance in our letter-based depends in part on whether a subject's native language uses the Latin alphabet.

[27] The variable *isUSborn* correlates with time taken to make Choice selection (negative), whether ever taken calculus or statistics courses (negative), age (negative) and whether male subject (negative). Potentially, risk preferences may also vary with nativity, although there is no significant relationship between HL score and the variable *isUSborn*.

(age, USborn, isCalculus), initial assets (iAssets) and its squared term (iAssets_sq).[28]

The estimates of interest are the coefficients on the treatment dummies, β_1, β_2 and β_3. If framing and the temporal ordering of risks affects the annuity decision, we expect $\beta_1 < 0, \beta_2 > 0$ and $\beta_3 < 0$. The coefficients measure the change in the probability under the endowment treatment relative to the No Endowment case and the change in the probability under the Sequential frame relative to the Simultaneous frame.

Table 4 presents the coefficients from the probit estimation. In the first column, we present the estimated effect of the treatments without any controls. In the second column, we present the estimated effect with controls for only risk preferences and cognitive ability. In the third column, we present the estimated effect of the treatments with the full set of controls. This is our preferred specification.

There are three important points to take away from the above table. The first is that looking across the three columns, we see that the Sequential Frame is both statistically and economically meaningful in all three specifications. In the preferred specification (column (c)), subjects in the Sequential frame are 12.8 percentage points less likely to choose the annuity option that subjects in the simultaneous frame. The results are as hypothesized. That is, when subjects are faced with the period by period possibility of "death", the annuity option appears relatively less attractive than when they are faced with a single draw.

The second point is that endowment effects appear to be present, however, they are significant only in the Annuity treatment and not in the Lump-Sum treatment. Both endowment treatments changed the probability of choosing the annuity option in the expected direction, however, the difference was statistically different from zero only in the Annuity endowment treatment. Subjects in those sessions were 13.5 percentage points more likely than subjects in the No endowment sessions to choose the Annuity option.

The third point of note from Table 4 is that (normalized) account balances appear to be an important determinant of the annuity choice. Each dollar increase in the account balance increases the probability of selecting the annuity option. Furthermore, because account balances were correlated with the endowment treatments, their exclusion biased the estimated treatment coefficients. This is evident from the comparison of the Lump-Sum and Annuity coefficients in columns (2) and (3).

[28]We experimented with alternate specifications. We included more or different cognitive ability controls (Time taken to make choice selection, total quiz scores, whether male dummy, whether taken statistics dummy). In some specifications, to increase sample size, we included all cases with missing Holt-Laury scores and included a dummy to identify those observations. The signs on the coefficient of interests in almost all these specifications remained unchanged although in some instances, the coefficients were no longer precisely estimated. This was generally the case when more covariates were added and degrees of freedom were lost. We also estimated a probit interacting the lump-sum endowment and the annuity endowment treatments with the sequential treatment - the estimated coefficients on the interaction terms were not significantly different from zero and those results are not reported in this paper.

Table 4: Testing Hypothesis One: Probit Estimate of the Effect of Sequential And Endowment Treatments on Annuity Choice

	(1) dy/dx	(2) dy/dx	(3) dy/dx
Sequential Treatment			
Sequential Frame	-0.094*	-0.130**	-0.128**
	(0.05)	(0.06)	(0.06)
Simultaneous Frame (omitted)			
Endowment Treatments			
Lump-Sum Endowment	-0.143**	-0.165**	-0.075
	(0.07)	(0.08)	(0.08)
Annuity Endowment	0.028	0.038	0.135*
	(0.06)	(0.07)	(0.07)
No Endowment (omitted)			
Risk Preferences			
HL Score Spline1		-0.043	-0.045
		(0.03)	(0.04)
HL Score Spline2		-0.001	-0.000
		(0.02)	(0.02)
Relative Payouts			
Dummy: Payout II		-0.122**	-0.149***
		(0.06)	(0.06)
Cognitive Abilities			
Dummy: Ever taken Calculus		0.119	0.068
		(0.09)	(0.09)
Dummy: US born		0.073	0.057
		(0.06)	(0.06)
Age		0.003	0.003
		(0.01)	(0.01)
Account Balance			
Account Balance (iAssets)			7.724***
			(2.44)
Account Balance Squared (iAssets_sq)			-4.052***
			(1.34)
Constant			
Observations	313	241	241
LR chi2	12.04	21.96	34.42
Prob¿chi2	.007	.009	.000
Log likelihood	-177	-125.4	-119.1

Notes:
* p<.10, ** p<.05, *** p<.01

The estimated effect of other covariates are as predicted. Increasing the relative expected payout of the lump-sum option reduces the probability of choosing the annuity option. Initial assets and assets-squared increases the probability of choosing the annuity.

5.3 Testing Hypothesis Two

We next turn to testing the second hypothesis, which is our policy exercise. If endowment effects matter in the annuity decision, then switching the frame of reference from the current Lump-Sum (account balance) frame to an Annuity (per-round payment) frame should increase the probability of choosing the annuity.

We test this hypothesis on a subset of our original sample. To evaluate the initial-endowment effect, we use the Lump-Sum treatment as our counterfactual. We estimate

$$Pr(Y_i = 1) = \alpha_0 + \alpha_1 ANN_i + \alpha_2 SEQ_i + \alpha_z Z_i + \epsilon_i \tag{6}$$

The coefficint α_1 gives the estimated change in annuity choice probability results form changing the denomination of initial endowments form a lump sum of assets to an annuity. $\alpha_1 > 0$ is is consistent with Hypothesis 2.

We first consider only subjects in earned-endowment treatments, reducing our sample size to 169 observations. This specification includes subjects from both Simultaneous and Sequential treatments. Therefore, the estimated effect is a weighted average from these 2 different sets of treatments.

To address the policy question of whether and how much changing the endowment frame would affect annuity choice, we re-estimate the probit on a resticted sample of only those subjects in the Sequential frame (since Lump Sum, Sequential mimics the status quo). This reduces our sample size to 81 observations.

Table 5 presents the results for both these specifications. Most notably, changing the frame of reference from the Lump Sum to Annuity may well produce and sizeable and significant effect on annuity choice. In the experiment, the probability annuity choice increases by 21.6 percentage points in the first specification. In the policy exercise specification, the estimated effect is even larger. Changing the frame of reference to annuity increases the probability of selecting the annuity option by 32.4 percentage points.

6 Discussion

Since Yaari's (1965) seminal work, a large literature has developed to explain why observed annuitization rates are lower than generally predicted under standard neoclassical models. Even after accounting for bequest motives, precautionary saving for uninsured medical expenses in late life and social annuities, these models are generally unable to fully explain the gap. Recent evidence suggests that relaxing the assumption of expected utility maximization may provide additional traction in explaining the annuity decision. Along these lines, this paper focuses the potential for two behavioral biases—a temporal bias given sequential survival and loss aversion stemming from an endowment effects—to contribute to explaining the reluctance to annuitize retirement assets in 401(k) accounts. We evaluate

Table 5: Testing Hypothesis Two: Probit Estimate of the Effect of Changing the Frame of Reference on Annuity Choice

	(1) dy/dx	(2) dy/dx
Endowment Treatments		
Annuity Endowment	0.218***	0.324***
	(0.07)	(0.11)
Lump-Sum Endowment (omitted)		
Sequential Treatment		
Sequential Frame	-0.131*	
	(0.07)	
Simultaneous Frame (omitted)		
Risk Preferences		
HL Score Spline1	-0.055	-0.253**
	(0.04)	(0.12)
HL Score Spline2	0.016	0.091**
	(0.03)	(0.04)
Relative Payouts		
Dummy: More Equal Relative Payouts	-0.196***	-0.231**
	(0.07)	(0.10)
Cognitive Abilities		
Dummy: Ever taken Statistics	0.118	0.068
	(0.11)	(0.21)
Dummy: US born	0.007	0.280**
	(0.08)	(0.13)
Age	0.010	-0.014
	(0.01)	(0.03)
Account Balance		
Account Balance (iAssets)	7.987***	12.860***
	(2.47)	(4.80)
Account Balance Squared (iAssets_sq)	-4.185***	-6.878**
	(1.36)	(2.69)
Constant		
Observations	169	81
LR chi2	33.56	28.45
Prob¿chi2	.000	.001
Log likelihood	-81.16	-36.61

Notes:
* p<.10, ** p<.05, *** p<.01
(1) Sample includes Endowment sessions only
(2) Sample includes Sequential Endowment sessions only

the strength of these two biases in an experimental setting by comparing the probability of choosing annuity over lump sum as we modify the survival-probability and endowment frames.

We find strong evidence that subjects are less likely to prefer the outcomes corresponding to an annuity's when presented with a sequential survival frame (Sequential) than when these same outcomes are presented in a frame that strips away the outcomes' temporal ordering (Simultaneous). Since subjects in both Sequential and Simultaneous groups receive identical information except for the presentation of survival probabilities, the result suggests that a framing of retirement outcomes that gives salience to the possibility of an "early death" reduces the relative attractiveness of an annuity. This is the case primarily because the path of utility matters to the subject: the value of an annuity comes from living longer periods, consequently undue weight on the probability of an early death reduces its value. Extrapolating beyond the laboratory, this result could provide empirical support for the claim that retirees are reluctant to purchase annuities because they are overly concerned with the possibility of an early death.

At this point, we certainly cannot and do not rule out the possibility that difficulties with probabilities may be biasing our result. Whereas we present unconditional retirement length probabilities in the Simultaneous treatments, we use conditional probabilities in the Sequential frame. The use of conditional probabilities may complicate expected value computations. Since the conditional probabilities of survival in early rounds are higher than in later rounds, errors in computation may potentially explain the relative preference for lump sum in the Sequential frame. Therefore, one of our next steps is to implement the Sequential frame where both the conditional and the unconditional survival probabilities are made explicit (Sequential II).

We also find evidence of an endowment effect: the denomination of assets matters. Subjects endowed with per-round payments (the annuity frame) were far more likely to choose the annuity option than those those endowed with a lump sum of assets or those not explicitly endowed with a payout option. However, subjects endowed a lump-sum frame were not more likely to choose the lump-sum option. It is somewhat surprising that the change from No Endowment to Lump Sum produces no effect whereas the change from Lump Sum to Annuity produces sizeable effects.[29]

Taken together, these results generate two policy implications First, one oft-cited reason for not purchasing an annuity is the "hit-by-the-bus" concern—that of dying soon after buying an annuity. Many policy proposals to increase annuitization generally argue that annuities be sold with guarantees to ameliorate this concern. We hypothesize that guarantees may provide an incomplete fix as a combination of an endowment effect and a temporal bias underly the concern and it is unclear exactly what the guarantee ameliorates. One the one hand, a guarantee might help mitigate an endowment effect stemming from loss aversion (the entire asset is not lost in the event of an early death) while providing no relief for temporal bias.[30] On the other hand, it might "insure" against early death but fail to mitigate the attachment to the lump sum and improve the perceived trade. Our experimental evidence suggests that temporal bias matters quite significantly but endowment effects are relatively small in the annuity decision. In the context of "hit by the bus", it suggests that the chance of early death weighs heavily on the annuity decision. However, without fully identifying

[29]As previously noted, this may be due to the small number of subjects in the Lump-Sum frame with account balances that were comparable to account balances of subjects in the No Endowment groups. Thus, an additional next step is to conduct more Lump-Sum sessions but scale the points such that account balances are more comparable with the No Endowment sessions.

[30]Guarantees might also have the unintended consequence of increasing focus on an early death!

exactly what guarantees insure against, we can only speculate that guarantees are a partial fix for this bias.[31]

A second implication is that our results support the hypothesis that changing the denomination of 401(k) assets from a lump sum to a claim on a per-period payment would increase annuitization. This suggestion has been proposed in policy circles and would be a relatively inexpensive and straightforward option to implement. We definitely do not, however, make any "magnitude" claims as differences between the laboratory and the "real world" make it difficult to extrapolate the estimated marginal effects. We certainly do not rule out the possibility that there are other unmeasured biases "in the wild" (such as loss of control, especially paired with investor over-confidence) that may continue to inhibit or limit demand for annuities even after implementing the policy fix.[32]

[31] It may be, for instance, that guarantees fully mitigate the temporal bias but other biases limit demand.

[32] Some of these biases may also underlie the "hit by the bus" concern and still make guarantees a partial fix.

A Optimal Consumption

A.1 No Endowment Treatments

We assume no inflation and set the risk-free interest rate equal to zero. We further assume that a representative retiree enters retirement with a stock of wealth W, and can survive from 1 to 15 periods with each retirement length equilikely. Under these assumptions, and letting p_t be the probability of surviving at least to period t, the actuarially fair annuitization of W pays

$$y = \frac{W}{\sum_{t=1}^{15} p_t} = \frac{W}{8}$$

each period starting in the first period (Creighton and Piggott 2006). To simplify matters, we assume that the retiree consumes her entire annuity payment in each period ($c_t = y$).[33]

We assume that the retiree who does not annuitize retirement wealth optimally consumes from her stock of wealth W. The solution to this optimization problem will depend on her utility function as well as survival probabilities. We assume constant relative risk aversion (CRRA), with $u_t(c_t) = \frac{c_t^{1-\rho}}{1-\rho}$ the per-period utility function of our representative retiree with ρ the coefficient of relative risk aversion. We implement a rational attraction to maintaining a stock of wealth (i.e., make reasonable a "hit by a bus" concern) by assuming a bequest motive. We assume that the value of a bequest of wealth is $v(w_t) = \beta \frac{w_t^{1-\rho}}{1-\rho}$, where w_t is wealth remaining as of time t. The retiree thus solves the following:

$$max_{c_t} E(U) = u(c_1) + \sum_{t=2}^{15} \left[p_t \cdot u(c_t) + (1 - \frac{p_{t+1}}{p_t}) v(w_t) \right] \tag{7}$$

subject to:

$$w_t = W - \sum_{\tau=1}^{t} c_\tau;$$
$$c_{15} = w_{15}; \text{ and}$$
$$p_{16} = 0;$$

where

$$u(c_i) = \frac{c_i^{1-\rho}}{1-\rho} = \frac{v(\cdot)}{\beta}.$$

We consider $\rho = \frac{1}{3}$,[34] $\beta = 0.865$,[35] and $W = 1000$. We solve for optimal consumption, and

[33] Under our assumptions, reallocating consumption between retirement periods subsequent to annuitization decreases utility. However, a retiree with a bequest motive might find it optimal to not consume her entire annuity payment.

[34] We choose this level of risk aversion to match median and modal levels of risk aversion exhibited by experiment subjects. Holt and Laury (2002) find a median level of risk aversion in the range of $0.15 < \rho < 0.41$ for low-stakes gambles (safe choice pays approximately \$1.80) and $0.41 < \rho < 0.68$ for high-stakes gambles (safe choice pays approximately \$36.00).

[35] We initially choose this high weight on bequest motives for a few reasons. First, we are interested in

scale utility by dividing by 20.

In Figure 1a we depict the cumulative utility for the retiree who annuitizes and the retiree who consumes out of the lump sum of assets. In our **No Endowment** sessions, we desired to present all payoffs in multiples of \$0.05. We also desired to translate the payoffs, particularly those arising from the lump-sum option, into a rules easily explainable to subjects. We therefore offered subjects an annuity payment of \$2.00 per period as opposed to \$1.88. We set the lump sum account value equal to \$18.00, with round 1 Type-I (consumption) payment equal to \$2.25 in the first round. The "consumption" payment decreases by \$0.15 with each passing round. Type-I payments are subtracted from the account balance, and the subject choosing the lump-sum payout option receives a Type-II (bequest) payment equal to 30% of the amount remaining in the account as of the final round.

As a first step toward checking the robustness of our results to changes in the relative values of our subject payments, we slightly alter Payout I. We decrease the Type-I payment subject to annuitization to \$1.75 (akin to moving the annuity away from actuarially fair). Further, we decrease the annuity weight by decreases the fraction of the account balance received by the subject from 30% to 20% if the subject choose the lump sum. We depict the changes in Figure 1b.

A.2 Endowment Treatments

In the treatments in which a subject must earn her retirement endowment, we translate points earned in the Earnings Phase into either per-round payments or account balances in the Payout Phase.

We start by noting the following about the payoffs in the No Endowment treatments. First, we calculate α_I and α_{II}, the amount by which we need to multiply the per-round annuity payment to recover the round-one payment subject to choosing the lump sum. ($\alpha_1 == \frac{2.25}{2.00}$, and $\alpha_2 = \frac{2.25}{1.75}$). Second, letting x_1 be the round-one Type-I payment subsequent to choosing the lump sum, payments decrease each round by $\delta = \frac{x_1}{15}$. We use these relationships between the Annuity and Lump-Sum payouts in the No Endowment treatments in deriving payments for the endowment treatments.

We assume a linear relationship between points earned in the Earnings Phase and the stock of wealth brought into retirement by our representative retiree, $W_i = points \times \gamma$. An actuarially fair annuity pays $y_i = \frac{W_i}{8}$, yielding scaled per-period utility (and Type-I payment) $u_1 = .05\frac{y_i^{1-1/3}}{1-1/3}$. The round-one Type-I payment subsequent to choosing the lump sum is $x_1 = u_1 * \alpha$, subsequent Type-I payments declining by $\frac{x_1}{15}$ each round. The subject's

decisions where both annuities and the lump-sum distribution are attractive. With $\rho = \frac{1}{3}$, without regard for a loss of assets due to death (i.e., $\beta = 0$), the expected utility of the optimal consumption of the lump-sum is only 81% of the actuarially fair annuity's. Furthermore, we desire that both options deliver the same utility should the subject live for eight periods. This is the case with $\beta = 0.865$, and expected utility from the optimal consumption of the lump sum is 95% of the the actuarially fair annuity's.

account balance is the summation of Type-I payments over all rounds.

Ideally, we would like "average" performance in the Earnings Phase to correspond to the payouts available in the No Endowment treatments. We projected that the median subject would earn 90 points in the Earnings Phase. Setting $\gamma = 10$ results in $W = 900$, with an actuarially fair annuity paying 125 and scaled utility equal to 1.75, exactly the per-round payout for Payout II.

Table 6 shows the annuity payment and lump-sum value for a range of points earnings. In the experiment, 40% of subjects earned between 77 and 104 points, thus placing them within ±10% of the No Endowment payouts, and 56% earned between 71 and 111 points, placing them with ±15% of the No Endowment payouts.

Points Earned	Annuity Type-I	Lump Sum Account Balance		Points Earned	Annuity Type-I	Lump Sum Account Balance
51	$1.20	$12.32		101	$1.89	$19.44
52	$1.21	$12.48		102	$1.90	$19.52
53	$1.23	$12.64		103	$1.91	$19.68
54	$1.24	$12.72		104	$1.92	$19.76
55	$1.26	$12.96		105	$1.94	$19.92
56	$1.27	$13.04		106	$1.95	$20.08
57	$1.29	$13.28		107	$1.96	$20.16
58	$1.30	$13.36		108	$1.97	$20.24
59	$1.32	$13.60		109	$1.99	$20.48
60	$1.33	$13.68		110	$2.00	$20.56
61	$1.35	$13.92		111	$2.01	$20.64
62	$1.36	$14.00		112	$2.02	$20.80
63	$1.38	$14.16		113	$2.03	$20.88
64	$1.39	$14.32		114	$2.05	$21.12
65	$1.41	$14.48		115	$2.06	$21.20
66	$1.42	$14.64		116	$2.07	$21.28
67	$1.44	$14.80		117	$2.08	$21.36
68	$1.45	$14.88		118	$2.09	$21.52
69	$1.46	$15.04		119	$2.11	$21.68
70	$1.48	$15.20		120	$2.12	$21.84
71	$1.49	$15.36		121	$2.13	$21.92
72	$1.51	$15.52		122	$2.14	$22.00
73	$1.52	$15.60		123	$2.15	$22.08
74	$1.53	$15.76		124	$2.16	$22.24
75	$1.55	$15.92		125	$2.18	$22.40
76	$1.56	$16.08		126	$2.19	$22.56
77	$1.58	$16.24		127	$2.20	$22.64
78	$1.59	$16.32		128	$2.21	$22.72
79	$1.60	$16.48		129	$2.22	$22.80
80	$1.62	$16.64		130	$2.23	$22.96
81	$1.63	$16.80		131	$2.24	$23.04
82	$1.64	$16.88		132	$2.26	$23.28
83	$1.66	$17.04		133	$2.27	$23.36
84	$1.67	$17.20		134	$2.28	$23.44
85	$1.68	$17.28		135	$2.29	$23.52
86	$1.70	$17.52		136	$2.30	$23.68
87	$1.71	$17.60		137	$2.31	$23.76
88	$1.72	$17.68		138	$2.32	$23.84
89	$1.73	$17.76		139	$2.34	$24.08
90	$1.75	$18.00		140	$2.35	$24.16
91	$1.76	$18.08		141	$2.36	$24.24
92	$1.77	$18.24		142	$2.37	$24.40
93	$1.79	$18.40		143	$2.38	$24.48
94	$1.80	$18.48		144	$2.39	$24.56
95	$1.81	$18.64		145	$2.40	$24.72
96	$1.82	$18.72		146	$2.41	$24.80
97	$1.84	$18.96		147	$2.42	$24.88
98	$1.85	$19.04		148	$2.44	$25.12
99	$1.86	$19.12		149	$2.45	$25.20
100	$1.88	$19.36		150	$2.46	$25.28

Table 6: Mapping from points earned into Type-I payment for the annuity and Account Balance for the Lump Sum.

B Instructions and Payoff Tables

B.1 Instructions: No Endowment, Simultaneous

Introduction

- You are about to participate in a session in which you will make choices in situations in which the amount of money you receive depends on both your choice and chance. This is part of a study intended to provide insight into certain features of decision processes. I encourage you to follow the instructions carefully, as the amount of money you accumulate will depend on the decisions you make as well as chance. You will be paid in cash at the end of the experiment.
- *During the experiment, I ask that you please do not talk to each other.* If you have a question, please raise your hand and an experimenter will assist you.
- This experiment will consist of 2 parts: Part A and Part B.

Part A Procedures

- For Part A, you will first choose between the Blue and Orange payout options. Later in the experiment, you will draw 1 of 15 chips from a bag. Your payout depends on the chip you draw as well as whether you chose the Blue or Orange payout option.
- You will choose Blue or Orange first, and I will collect your Choice. You will draw your chip later in the experiment.
- You will draw 1 chip out of a bag containing 15 chips. Each chip is lettered, with letters ranging from A through O (the first 15 letters of the alphabet). Each chip has one and only one letter, and each letter is on one and only one chip. Prior to drawing, you may inspect the chips to verify this.
- I have just handed each of you a Choice Sheet.
- For each payout option, the payment you receive for a particular chip has been split into Type I and Type II payments. Your total payment for the chip you draw from the bag is the sum of Type I and Type II payments for the payout option you chose.
- The set of blue columns on the Choice Sheet indicates the Type I and II earnings, as well as your total earnings for each chip, if you choose Blue. The set of orange columns on the Choice Sheet indicates the Type I and II earnings, as well as your total earnings for each chip, if you choose Orange.
- Prior to making your choice, your monitor will display a series of review questions to test your understanding of these Experiment Instructions. You may refer to the

Experiment Instructions and the Choice Sheet in answering the review questions. You will be paid $0.10 for each correctly answered question.

- After completing the review questions, you will get as much time as you need to make your Choice. When you have made your Choice, please circle it in the place indicated on the Choice Sheet. I will collect the sheets when everyone has made a Choice.
- At the end of the experiment, I will pay you, in cash, your show-up fee and your earnings from Parts A and B of this experiment.
- Are there any questions?

B.2 Instructions: Lump-Sum Endowment, Sequential

Instructions Prior to Earnings Phase

Introduction

- You are about to participate in a session in which you will make choices in situations in which the amount of money you receive depends on both your choices and chance. This is part of a study intended to provide insight into certain features of decision processes. I encourage you to follow the instructions carefully, as the amount of money you accumulate will depend on the decisions you make as well as chance. You will be paid in cash at the end of the experiment.
- *During the experiment, I ask that you please do not talk to each other.* If you have a question, please raise your hand and an experimenter will assist you.
- This experiment will consist of 2 parts: Part A and Part B.

Part A Overview

- There are two phases to Part A: the Earning Phase and the Payout Phase.
- You earn points in the Earnings Phase by successfully completing tasks in each of two 4-minute periods. The number of points you earn in the Earnings Phase determines the the size of your Payout-Phase account. It is from this account that payments are made to you in the Payout Phase.
- The Payout Phase proceeds in a series of rounds. The number of rounds will be determined by chance. Your number of Payout-Phase rounds will be as few as 1 and as many as 15. In each round that your Part A lasts, you receive a payment from your account. After your final Part A round, you also receive a fraction of what is remaining in your account after the per-round payments to you have been subtracted. Your payment for Part A will depend on total funds you accumulate in your account during the Earnings Phase, as well as the number of Payout-Phase rounds.

- **The more tasks you successfully complete in Earnings Phase, the more points you generate, the larger the Payout-Phase account and thus the larger your Part A payment.**

Earnings Phase Procedures

- In each of two 4-minute periods, your computer monitor will present you with a series of tasks. For each task, your monitor first presents you with 5 letters. After you click the OK button, your monitor will present you with a series of 3 letters. You are then asked to click **Yes** if all of the new 3 letters were in the original 5 letters, and **No** if any the new 3 letters were not in the original 5.
- If your response is correct, your monitor will immediately present you with the next set of 5 letters. If your response is incorrect, your computer monitor will present a screen indicating that your response is incorrect. After clicking the OK button, your monitor will then present you with the next set of 5 letters.
- The computer will keep track of your correct and incorrect responses. The number of points you earn in an Earnings Period is the number of correct responses minus the number of incorrect responses in the 4-minute period. The number of points you earn in the Earnings Phase is the sum of the points you earn in the two Earnings periods.
- The Points Table indicates for each number of total points you accumulate in the Earnings Phase the funds in your account in the Payout Phase.
- The Earnings Phase starts with a short practice round. The purpose of the practice round is to give you an opportunity to familiarize yourself with the computer interface. You do not accumulate points in the practice round.

Payout Phase Procedures

- The number of points you earn in the Earnings Phase determines the value of your Payout-Phase account.
- Later in the experiment, I will call you up individually to determine your number of Payout-Phase rounds.
- You receive a payment from your Payout-Phase account each round. Your per-round payments are subtracted from your account. Your per-round payment decreases with each round.
- In each round, I present you with a bag of marbles. If you draw a green marble, you proceed to the next round and receive the per-round payment for that next round. If you do not draw a green marble, you do **not** proceed to the next round and your Part A is over. After your final round, you receive 20% of what remains in your account after your per-round payments have been subtracted.

- Note that you will receive all of the funds in your Payout-Phase account only if your Payout Phase lasts all 15 rounds.
- You start in round 1 and therefore collect the round 1 per-round payment. I will present you with a bag with 15 marbles, 14 of which are green. (If you wish, you may count the marbles in the bag.)
- If you select a green marble, you move on to round 2 and thus collect the round-2 per-round payment. I would then present you the same bag of marbles, which would now contain 14 marbles, 13 of which are green. Again, if you draw any one the green marbles, you move on to round 3, and collect your per-round payment for round 3. The bag would now contain 13 marbles, 12 of which are green.
- The rounds proceed until you fail to draw a green marble, at which point your Part A ends. You receive the per-round payment for each Payout-Phase round you last, as well as 20% of what remains in your account after the per-round payments have been subtracted.
- At the end of the experiment, I will pay you, in cash, your show-up fee and your earnings from Parts A and B of this experiment.
- Are there any questions?

Instructions After Earnings Phase

- I am now going to offer you an alternate payout schedule for the Payout Phase. I encourage you to listen carefully as you will be asked to choose between the original and alternate schedules.
- Depending on the number of Payout-Phase rounds, sometimes the original payout schedule will result in higher payouts, and sometimes the alternate payout schedule will result in higher payouts.
- Based on your points and thus the Payout-Phase account you earned, we have calculated your per-round payment for each Payout-Phase round. These are the Type-I payments on the Choice Sheet for the original schedule. We have also calculated 20% of the remaining account balance after per-round payments have been subtracted. These are the Type-II payments on the Choice Sheet for the original schedule.
- In the alternate payout schedule, there are also per-round Type-I payments, although unlike the original payout schedule these payments are equal in each round. You receive these Type-I payments for each round you last.
- If you choose the alternate payout schedule, in your final round, you do not receive a Type-II payment.

- The set of blue columns on the Choice Sheet indicates the alternate payout schedule. It indicates the Type-I payment for each round you last. The set of orange columns on the Choice Sheet indicates the Type-I and Type-II payments for the original payout schedule. Recall that you receive the the Type-I payment for **each** round, and receive only one Type-II payment: the Type-II payment associated with your final round. The last column of each color indicates your total Part-A earnings if you chose that option and your game lasts *exactly* a given number of rounds.
- The last set of columns indicates for each round the number of green marbles in the bag for that round as well as the total number of marbles. The final column indicates for each round the chance of drawing a green marble and thus proceeding to the next round.
- Prior to making your choice, your monitor will display a series of review questions to test your understanding of these Experiment Instructions. You may refer to the Experiment Instructions and the Choice Sheet in answering the review questions. You will be paid $0.10 for each correctly answered question.
- After completing the review questions, you will get as much time as you need to make your Choice. When you have made your Choice, please circle it in the place indicated on the Choice Sheet. I will collect the sheets when everyone has made a Choice.
- At the end of the experiment, I will pay you, in cash, your show-up fee and your earnings from Parts A and B of this experiment.
- Are there any questions?

B.3 Payoff Tables in No Endowment Treatments

	BLUE OPTION			ORANGE OPTION			
Chip	Type I Earnings	Type II Earnings	TOTAL Earnings for this Chip	Type I Earnings	Type II Earnings	TOTAL Earnings for this Chip	Chance You Draw this Chip
A	$2.00	$0.00	$2.00	$2.25	$4.70	$6.95	1/15
B	$4.00	$0.00	$4.00	$4.35	$4.10	$8.45	1/15
C	$6.00	$0.00	$6.00	$6.30	$3.50	$9.80	1/15
D	$8.00	$0.00	$8.00	$8.10	$2.95	$11.05	1/15
E	$10.00	$0.00	$10.00	$9.75	$2.50	$12.25	1/15
F	$12.00	$0.00	$12.00	$11.25	$2.00	$13.25	1/15
G	$14.00	$0.00	$14.00	$12.60	$1.60	$14.20	1/15
H	$16.00	$0.00	$16.00	$13.80	$1.25	$15.05	1/15
I	$18.00	$0.00	$18.00	$14.85	$0.95	$15.80	1/15
J	$20.00	$0.00	$20.00	$15.75	$0.70	$16.45	1/15
K	$22.00	$0.00	$22.00	$16.50	$0.45	$16.95	1/15
L	$24.00	$0.00	$24.00	$17.10	$0.25	$17.35	1/15
M	$26.00	$0.00	$26.00	$17.55	$0.15	$17.70	1/15
N	$28.00	$0.00	$28.00	$17.85	$0.05	$17.90	1/15
O	$30.00	$0.00	$30.00	$18.00	$0.00	$18.00	1/15

(a) Simultaneous

	BLUE OPTION			ORANGE OPTION					
Round	Type I: Payment this Round	Type II Payment if Last Round	TOTAL Earnings if Last Round	Type I: Payment this Round	Type II Payment if Last Round	TOTAL Earnings if Last Round	Number of Green Marbles in Bag	Number of Marbles in Bag	Chance of Continuing to Next Round
1	$2.00	$0.00	$2.00	$2.25	$4.70	$6.95	14	15	14/15
2	$2.00	$0.00	$4.00	$2.10	$4.10	$8.45	13	14	13/14
3	$2.00	$0.00	$6.00	$1.95	$3.50	$9.80	12	13	12/13
4	$2.00	$0.00	$8.00	$1.80	$2.95	$11.05	11	12	11/12
5	$2.00	$0.00	$10.00	$1.65	$2.50	$12.25	10	11	10/11
6	$2.00	$0.00	$12.00	$1.50	$2.00	$13.25	9	10	9/10
7	$2.00	$0.00	$14.00	$1.35	$1.60	$14.20	8	9	8/9
8	$2.00	$0.00	$16.00	$1.20	$1.25	$15.05	7	8	7/8
9	$2.00	$0.00	$18.00	$1.05	$0.95	$15.80	6	7	6/7
10	$2.00	$0.00	$20.00	$0.90	$0.70	$16.45	5	6	5/6
11	$2.00	$0.00	$22.00	$0.75	$0.45	$16.95	4	5	4/5
12	$2.00	$0.00	$24.00	$0.60	$0.25	$17.35	3	4	3/4
13	$2.00	$0.00	$26.00	$0.45	$0.15	$17.70	2	3	2/3
14	$2.00	$0.00	$28.00	$0.30	$0.05	$17.90	1	2	1/2
15	$2.00	$0.00	$30.00	$0.15	$0.00	$18.00	0	1	0

(b) Sequential

Table 7: Payouts I

	BLUE OPTION			ORANGE OPTION			
Chip	**Type I Earnings**	**Type II Earnings**	**TOTAL Earnings for this Chip**	**Type I Earnings**	**Type II Earnings**	**TOTAL Earnings for this Chip**	**Chance You Draw this Chip**
A	$1.75	$0.00	$1.75	$2.25	$3.15	$5.40	1/15
B	$3.50	$0.00	$3.50	$4.35	$2.75	$7.10	1/15
C	$5.25	$0.00	$5.25	$6.30	$2.35	$8.65	1/15
D	$7.00	$0.00	$7.00	$8.10	$2.00	$10.10	1/15
E	$8.75	$0.00	$8.75	$9.75	$1.65	$11.40	1/15
F	$10.50	$0.00	$10.50	$11.25	$1.35	$12.60	1/15
G	$12.25	$0.00	$12.25	$12.60	$1.10	$13.70	1/15
H	$14.00	$0.00	$14.00	$13.80	$0.85	$14.65	1/15
I	$15.75	$0.00	$15.75	$14.85	$0.65	$15.50	1/15
J	$17.50	$0.00	$17.50	$15.75	$0.45	$16.20	1/15
K	$19.25	$0.00	$19.25	$16.50	$0.30	$16.80	1/15
L	$21.00	$0.00	$21.00	$17.10	$0.20	$17.30	1/15
M	$22.75	$0.00	$22.75	$17.55	$0.10	$17.65	1/15
N	$24.50	$0.00	$24.50	$17.85	$0.05	$17.90	1/15
O	$26.25	$0.00	$26.25	$18.00	$0.00	$18.00	1/15

(a) Simultaneous

	BLUE OPTION			ORANGE OPTION					
Round	**Type I: Payment this Round**	**Type II Payment if Last Round**	**TOTAL Earnings if Last Round**	**Type I: Payment this Round**	**Type II Payment if Last Round**	**TOTAL Earnings if Last Round**	**Number of Green Marbles in Bag**	**Number of Marbles in Bag**	**Chance of Continuing to Next Round**
1	$1.75	$0.00	$1.75	$2.25	$3.15	$5.40	14	15	14/15
2	$1.75	$0.00	$3.50	$2.10	$2.75	$7.10	13	14	13/14
3	$1.75	$0.00	$5.25	$1.95	$2.35	$8.65	12	13	12/13
4	$1.75	$0.00	$7.00	$1.80	$2.00	$10.10	11	12	11/12
5	$1.75	$0.00	$8.75	$1.65	$1.65	$11.40	10	11	10/11
6	$1.75	$0.00	$10.50	$1.50	$1.35	$12.60	9	10	9/10
7	$1.75	$0.00	$12.25	$1.35	$1.10	$13.70	8	9	8/9
8	$1.75	$0.00	$14.00	$1.20	$0.85	$14.65	7	8	7/8
9	$1.75	$0.00	$15.75	$1.05	$0.65	$15.50	6	7	6/7
10	$1.75	$0.00	$17.50	$0.90	$0.45	$16.20	5	6	5/6
11	$1.75	$0.00	$19.25	$0.75	$0.30	$16.80	4	5	4/5
12	$1.75	$0.00	$21.00	$0.60	$0.20	$17.30	3	4	3/4
13	$1.75	$0.00	$22.75	$0.45	$0.10	$17.65	2	3	2/3
14	$1.75	$0.00	$24.50	$0.30	$0.05	$17.90	1	2	1/2
15	$1.75	$0.00	$26.25	$0.15	$0.00	$18.00	0	1	0

(b) Sequential

Table 8: Payouts II

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