Life Expectancy as a Constructed Belief:
Evidence of a Live-to or Die-by Framing Effect[i]

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Abstract

Expectations about how long one will live are essential for making informed choices about many important personal decisions. We propose that beliefs (expectations) about longevity are a response constructed at the time of judgment, subject to irrelevant task and context factors, and leading to predictable biases. Specifically, we examine whether life expectancy is affected by the framing of expectations questions, as well as by factors that actually affect longevity such as the age, gender, and self-reported health status of the respondent. One frame asks people to provide probabilities of **living to** a certain age or older; the other frame asks people to provide probabilities of **dying by** a certain age or younger. These two answers should be complements, but we find that estimated probabilities differ significantly in the two conditions. People in the live-to frame report that they have a 55% chance of being alive at age 85, whereas people in the die-by frame report that they have a 68% chance of being dead at age 85. Overall, estimated mean life expectancies, across three studies and over 2300 respondents were between 7.38 to 9.17 years longer when solicited in the **live-to** frame. We compare estimated life expectancies with Social Security Administration (SSA) life tables and find that the judgments of individuals in the live-to frame were closer to actual life expectancies for ages 65 and 75, while in the die-by condition, the respondents were more accurate for older ages, e.g., age 95. On a process level, we show that the framing effect on judgments is partially mediated by the relative number of thoughts in favor of being alive at that age. Finally, we find that individual differences in life expectancies relate to differences in stated preference for life annuities, a product that provides insurance against outliving one's savings. The implications of "constructed" life expectancies for models of financial decision making, and for improving financial decision making are discussed.

Introduction

An individual who plans for the future must, in one way or another, consider how long he or she expects to live. For instance, the almost 80 million baby boomers approaching retirement in the United States will have to plan for the possibility of living 10, 20, 30, or more years beyond retirement, plans that depend critically on each individual's own predicted life expectancy. At the other end of the life cycle, Fischhoff et al. (2000) suggest that teenagers' life expectancy judgments may cause them take more risks because they exaggerate the probability that they are not going to live beyond age 20. Also, as noted by Elder (2007), and others, subjective life expectations play a central role in the Maximization of the Expected Utility of Lifetime Consumption model (or Life-Cycle model, see Browning & Crossley, 2001).

Judgments of longevity are typically assumed in economics to be relatively accurate expectations, reflecting personally held information about one's own likelihood of living to various ages expressed with only random error (Hurd, 2009). Examples of more personally held information are the longevity of one's parents or the healthiness of one's lifestyle; Perozek (2008) offers arguments for why individuals may be uniquely qualified to predict their own mortality. Typically, survey respondents' subjective probabilities (life expectancies) closely correspond with actuarial life tables. For example, Hurd (2009) reports a comparison where the overall average subjective probability for age 75 was 64% compared to a life table probability of 68%. Elder (2007) finds that actual survival rates track predicted survival rates (those who give higher probabilities are more likely to survive). Additionally, subjective probability judgments are generally coherent, i.e., the probability of living to age 85, on average, is judged less than the probability of living to age 75, although slope tends to be underestimated. In our studies we only use the responses of subjects who satisfied the minimal coherence criterion that the probability of living-to an earlier age (e.g., 75) was at least a great as the expressed probability of living to an older age (e.g., 85) for all the responses provided by a respondent. For a further discussion of conditions for survey responses as valid expressions of probabilities, see Viscusi and Hakes (2003).

In this paper, we investigate the hypothesis that beliefs about how long one might live are, at least in part, a response constructed at the time of judgment based on the selective retrieval of information from memory. The idea that longevity beliefs are constructed suggests that these judgments, which relate to a wide variety of important personal decisions from health to wealth, will be contingent upon a variety of framing, procedural, and context factors as well as valid personal knowledge and random error. More specifically, we hypothesize that simple changes in the framing of the life expectancy question will influence the selective retrieval of information from memory which leads to predictable biases in subjective probability judgments of longevity.

We present three studies of life expectancy judgments involving over 2000 respondents ranging in ages from 18 to 83 years old. Each study asks half of the respondents to provide probabilities of **living to** a certain age or older and the other half of the respondents to provide probabilities of **dying by** a certain age or younger. The answers to these two questions should perfectly mirror each other, with the probability of living to a given age being one minus the probability of dying by that age. If framing has an effect, then implied probabilities will significantly differ in the two question conditions.

Study 1 tests whether framing predictably affects life expectancy judgments and also examines whether reported life expectancies relate to respondents' ages and gender in ways that reflect actuarial truth. Study 2 replicates the framing effect and examines if expressed subjective longevity probabilities incorporate self-reported health status, a form of personally held information. Our first two studies find that the framing effect is substantial (often larger than the effects of subjective health, current age, or gender). In the live-to frame, for example, people thought they had about a 55% chance of being alive at age 85; however, in the die-by frame people thought they had only a 32% chance (i.e., a 68% chance of being dead at age 85). The mean life expectancies, across the first two studies involving nearly 2000 respondents, was 8.68 years longer in the **live-to** frame than the die-by frame.

Study 3 goes beyond demonstrating the framing effect and investigates the cognitive processes that may underlie the differences. In particular, we examine whether differences in responses across frames are mediated by differences in the types of information retrieved in the two question formats. We find that respondents had relatively more positive thoughts about being alive at age 85 in the "live-to" condition than in the "die-by" condition, and this in turn, predicted subjective probabilities of being alive at age 85.

Taken together, the three studies extend the increasingly accepted idea of constructed preferences to the domain of beliefs, while also offering evidence that the constructed beliefs reflect both personal (health and age) and public (gender) information in a way that tracks Social Security actuarial data. Because life expectancies have important implications for critical long-term financial choices, we next present some data showing that the constructed life expectancies relate to expressed preference for life annuities, a product that provides insurance against outliving one's savings. We then discuss the implications of the "constructed" beliefs perspective for standard life-cycle consumption models of many financial decisions. We end by discussing the implications for improving consumer financial decision making suggested by a more constructed perspective regarding beliefs and values.

Before presenting the details of each study we next turn to a brief review of work on life expectancies and on how question framing impacts choices and judgments.

Beliefs about Longevity

The concept that consumers' forecasts of their life expectancies (their subjective probabilities) influence many economic decisions is widely accepted. Consequently, there is growing effort to collect these subjective probability judgments (see Hurd, 2009, for a recent review of studies on life expectancies). The most influential of the life expectation surveys has been the Health and Retirement Study (HRS) conducted since the early 1990s. The HRS interviews people age 50 or older and includes a question using a 101-point scale (zero to 100) asking a person's belief that he or she "will live to be 75 or more." More recently, the HRS has also asked the chance of living to age 85 or beyond. Another influential survey, the Survey of Consumer Finances (SCF) sponsored by the Federal Reserve, asks, "About how long do you think you will live?" A survey of teenagers asked its respondents (mean age 15.8) the probability of "dying by" age 20 (Fischhoff et al., 2000). Subjective probability responses about expected longevity are also collected internationally (see, for example, van Solinge and Henkens, 2009). While a "live to" frame and a probability response are often used in surveys, other framings of life expectancy questions and other forms of response (e.g., an age rather than a probability) are also used.

The standard theoretical view has been that subjective judgments of life expectancies are unbiased, reflecting personally held information about one's likelihood of living to various ages, expressed with some random error or noise. The assumption that personal longevity judgments incorporate information people have about their own health, as well as more public actuarial information they have about how survival probabilities vary by age, gender, and race, appears to be true to some extent. For instance, self-rated health appears to have predictive power beyond what is contained in life tables (Hurd, 2009). While subjective survival probabilities tend to generally reflect actual survival, some researchers have found evidence of systematic mispredictions (Elder 2007). For example, subjective survival rates are lower than actual probabilities for ages below 80 but are higher than actual for ages above 80. Research also suggests that men are relatively more optimistic than women about their likelihoods of living to older ages, i.e., beyond age 85.

In addition, some researchers have argued that individual estimates of life expectancies may reflect certain motivational biases. Ludwig and Zimper (2007), for instance, suggest that subjective life expectations become more optimistic as people attain age 80 because of a desire to avoid feelings of despair about death. On the other hand, Fischhoff et al. (2000) present evidence that teenagers are pessimistic with regards to life expectations and suggest this may be due to a perceived lack of control over their world. It has also been proposed that life expectancies reflect a person's general degree of optimism (Puri & Robinson, 2007).

To summarize, prior research suggests that subjective probabilities for events such as survival, where individuals have considerable personal information, have "considerable predictive power" (Hurd, 2009). Nonetheless, Hurd argues that research needs to continue on the properties of the subjective probabilities of events such as longevity, including how those subjective probabilities are formed. We agree completely. This paper suggests that belief judgments, even for events such as longevity where people have substantial valid knowledge, are "constructed" responses based upon information accessible at the moment of judgment. Consequently these responses will also reflect normatively irrelevant task variations such as question framing that are likely to make certain types of information more or less accessible.

Framing

Framing effects provide some of the most compelling evidence of the constructive nature of human preferences (see Keren, 2011, for a review). While the majority of previous framing studies have involved either evaluations or choices between options and assumes the mechanism to be the coding of outcomes as gains versus losses (Kahneman & Tversky, 1979), our research focuses on how framing affects a prediction question (judgment) and assumes a mechanism based on selective retrieval of information. The vast majority of framing studies manipulate frames either in terms of how outcomes are described, e.g., Keep (gain) or Lose (De Martino et al., 2006) or how the decision problem itself is framed, e.g., an annuity decision described as an investment, an insurance purchase, or a gamble (Brown et al., 2011; Brown et al., 2008; Schultz, 2010). In contrast, the present research adopts a form of framing, called attribute framing (e.g., ground beef described as 75% lean versus 25% fat).That is, we adopt the attribute framing of the probabilities of **living to** a certain age or older versus frame of the probabilities of **dying by** a certain age or younger.

The effects of attribute framing on choices have often been explained in terms of making certain types of information more or less accessible rather than the perceptual or evaluative coding of outcomes (Keren, 2011). We hypothesize that different attribute frames for predicting an event, such as living to a certain age or longer or dying by a certain age or younger, will also cause a person to access different information (e.g., relatives who have lived long versus relatives who have died younger), yielding a biased response. We adapt Query Theory (Hardisty, Johnson, & Weber, 2010; Johnson, Häubl, & Keinan, 2007; Weber, Johnson, Milch, Chang, Brodscholl, & Goldstein, 2007), which has proven successful in understanding elements of preference construction, to the construction of beliefs about future events. We hypothesize that life expectancies asked in the live-to frame will generate more initial positive thoughts about living whereas those in the die-by frame will generate more initial thoughts about death or dying, and that subjective probability judgments about longevity will then reflect the balance of arguments within the given frame (see Support Theory by Tversky and Koehler, 1994).

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Study 1

Our first study addresses two sets of questions. One set deals with whether life expectancies change depending upon whether people are asked to provide probabilities of **living to** a certain age or older or they are asked to provide probabilities of **dying by** a certain age or younger. That is, does even a belief like a life expectancy show evidence of being a constructed judgment? And, if there are significant differences due to framing, are the differences in assessed probabilities large enough to be meaningful in personal financial decision making? The second set of questions deals with how well people assess their probabilities of living to various ages as a function of frames – in other words, how accurate are individuals' estimates relative to actuarial data?

Participants

A convenience sample of U.S. residents (N = 1444) were recruited and run online through the internet panel company Survey Sampling International. Participants (54.6% female, M_{age} = 50.9, aged 18 to 83). Respondents were paid a fixed amount for participation. Note that the use of an internet survey differs from surveys like the Health and Retirement survey which has used in-person or telephone interview methods.

Method

Participants were randomly assigned to the live-to or the die-by condition, and were asked to estimate and report the chance that they would live to [die by] a certain age or older [younger] using a slider scale. As shown in Figure 1a (live-to) and 1b (die-by), participants responded using a slider with 101 possible values from 0-100%. The wording of the live-to version is designed to mimic that used in the Health Retirement Survey (see, for example, Elder, 2007). Although the HRS uses primarily a live-to frame, recently a follow-up question in the HRS asks "Do you think that it is about equally likely that you will die before 85 as it is that you will live to 85?". Also, like more recent versions of the HRS, respondents in our survey could, and did, use numbers ranging from 0 to 100 to express their beliefs.

Half of the participants received scales starting from (anchored on) 0% on the left and the rest of the participants received scales starting from 100% on the left to control for possible anchoring effects due to scale design. We also control for anchoring effects by varying the starting target age. While all participants provided estimates for every 10 years up to age 95, one-third started at age 55, one-third started at age 65, and one-third started at age 75. As noted earlier, in our studies we only use the responses of subjects who satisfied the minimal coherence criterion that the probability of living-to an earlier age, e.g., 75, was at least a great as the expressed probability of living to an older age, e.g., 85, for all the responses provided by a respondent. With probabilities elicited for four ages, 65-95, for example, this meant that for each subject there are at three comparisons that had to meet this minimal condition of coherence. Overall, this condition multiple pairs of judgment coherence was met by 84% of the people who took the survey. Since all participants provided estimates for 75 years, 85 years, and 95 years, we focus on these common estimates in the analyses below.

Insert Figure 1a and 1b about here

If the assessed life expectancies reflect relevant as well as irrelevant factors, both age and gender should have predictable effects on the life expectations. Thus, in all studies we collected information on both the age and gender of all the respondents.

Results

For ease of comparison, we present all of the life expectation estimates as the reported probabilities of living to age X or older. For example, if a respondent gives a 56% chance of **dying by** 85 years old or younger, we report the converted response of a 44% chance of **living to** age 85 years or older. First, it is important to note that in this study, the average subjective probability of being alive at age 75 across frames was 63.7%. Elder (2007) reports that average probability of being alive at age 75 was 65% among the respondents in The Health and Retirement Survey, which used a similar 101-point probability (chance) scale. The respondents in the HRS were all over 50 years of age. Given that the respondents in this survey were slightly younger than those in the HRS survey, this suggests that the life expectations data collected in this survey produced reasonable estimates, at least at a first approximation. For comparison, the Social Security Administration (SSA) tables suggest that an American's average probability of living to age 75 is about 67%. Thus, although our sample is a convenience sample, there seems to be a reasonable correspondence between the data collected in this study, the data collected in the HRS, and actual longevity data reported by the SSA. We present a more detailed comparison of the present survey results and the SSA data later.

However, as Mirowsky (1999) has noted a correlation between subjective and actuarial estimates of the number of years of life remaining is not enough: "If everyone guessed the actuarial estimate minus five years the correlation would be perfect but the difference considerable" (p. 968). Thus, we next examine whether there is evidence of a framing effect on the expressed probabilities of living-to or dying-by various ages.

Figure 2a summarizes the results for each target age, including 90% confidence intervals. To illustrate the size of the framing effect, please note that people in the live-to frame(Fig. 2a) judged that they had about a 55% chance of being alive at age 85, whereas people in the die-by frame thought they had about a 68% chance of being dead at age 85 (i.e., 32% chance of being alive at age 85). This 23% difference in probabilities of being alive at age 85 was highly significant using an OLS regression analysis ($p < .001$)[ii]. Note from Figure 2 that there was also a ten-year gap in median expected age of death (around 85 years for the live-to frame and 75 years for the die-by frame). The average probability judgments for age 85 also showed significant ($p < .005$) effects for gender and the age of the respondent, although the size of the effects were smaller than for framing, i.e., a 4 percentage point gap for gender (women more likely to be alive) and a .2 percentage point increase in assessed probability for each additional year of age for the respondent.

The analysis showing the strong effect of framing on life expectation on each target age used the responses from the complete set of subjects. However, as noted above, one-third of the respondents started the expectation tasks at age 55, one-third at age 65, and one-third at age 75. We did not, however, find evidence for an anchoring effect of using a different starting age on expectations. The lack of an anchoring effect suggests that the expectations judgments participants are providing are robust to other common judgment biases, an important indication that individuals are thinking carefully about their responses. Regardless of the initially judged age, asking a **living to** question or a **dying by** question had a larger significant and meaningful difference in observed responses.

In addition to examining the subjective probabilities separately for each age, we created a single comprehensive measure for each respondent. More specifically, for each individual respondent, we estimated a set of Weibull parameters based on the individual's current age and the full set of probability responses. (The Weibull estimates assume a 0% chance of being alive at 130 years old to provide a reasonable ceiling to the model estimates; additional details about how these estimates were performed is provided in Appendix A.) Using the estimated Weibull parameters per participant, a mean life expectancy was estimated per individual, at which the model predicted that person's chance of being alive to be exactly 50%.

A regression model testing the mean life expectancy as estimated per individual as a function of the age of the respondent, gender, and frame showed effects consistent with those reported above for the subjective probability estimates for specific ages, with framing having the largest effect of an additional 9.17 years added to mean life expectation when responses were solicited for the live-to frame. For comparison, each extra year in the age of the respondent was associated with 0.14 additional years in mean life expectancy and being a woman was associated with 1.08 years in extra mean life expectation. As suggested by Viscusi and Hakes (2003) the positive and significant effect of the age of the respondent on the mean life expectation provides perhaps the most salient test of the plausibility of the elicited subjective probabilities. Also, note that the significant effect of framing on mean life expectancy also held even when controlling for age and gender again suggesting that this basic life expectancy prediction was, at least in part, a constructed response. See Table 1a for the coefficients for Study 1 and the standard errors.

Insert Table 1 and Figure 2 about here

Relationship between Life Expectancy Judgments and Social Security Data . As noted above, past research has investigated the correspondence between subjective life expectancies from the HRS data and actuarial estimates from SSA life tables. Also, Viscusi and Hakes (2004) argue that a second test of the validity of survival questions is to examine the relationship between elicited probabilities and actual survival probabilities. We do such a comparison for the data collected in this study by using the 2006 SSA life tables to calculate a series of probabilities of being alive at 65, 75, and 85 for each participant based on their age and gender. We then take the difference between each participant's subjective probability and their actuarial probability to generate a measure of overestimation (positive difference) or underestimation (negative difference) about their chances of living to each age. Frame has a significant effect on the average difference score, with individuals in the live-to frame overestimating their chances of living to each age more than participants in the die-by frame ($t = 14.29$, $t = 16.13$, and $t = 14.33$, for ages 75, 85, and 95, respectively, all $p < .001$). Consistent with prior findings for the HRS data (Elder 2007), subjective probabilities are significantly lower than actuarial estimates (i.e., underestimated) for ages below 80 (for age 75, mean difference = -11.99 years, $p < .001$) and significantly higher than actuarial estimates (i.e., overestimated) for ages above 80 (for age 85, mean difference = 1.72 years, $p = .01$).

To summarize, strong evidence of a framing effect on life expectancies was found suggesting that such judgments are "constructed" beliefs. Further, the size of the effect is substantial and could have important implications for critical financial choices with major long-run consequences.

Study 2

This study tests whether the strong framing effect found in study 1 replicates, again using the probability scale response mode. However, in this study the focus is on respondents aged 45 to 65 that are comparable to the ages of respondents in the HRS, the preeminent dataset used to study the financial decision making of older Americans. Respondents of age 45 to 65 are likely to have begun to think about life expectation and retirement. In this study we also collect more detailed information on individual respondents including their age, gender, ethnicity, and their current health than in study 1. The individual level of information on current health, in particular, can be considered personally held knowledge related to one's life expectancy. We also included a measure of numeracy, a factor that has been previously linked to assessments of life expectations, and that is considered to be important for retirement planning.

Participants

U.S. residents (N = 514) aged 45 to 65 were recruited and a survey run online through the internet panel company Survey Sampling International (45.1% female, Mean age = 56.4). While the age restriction for this sample makes the sample more similar to that used in the HRS, it may also restrict any relationship between age and life expectancies. Eighty-six percent of the respondents were Caucasian, 8% African-American, and 6% other races.

Method

Participants reported the chance that they would live to [die by] a certain age or older [younger] using the slider scale from study 1. As in study 1, half of the participants received a scale starting from 0% on the left and the rest of the participants received a scale starting from 100% on the left. All participants provided estimates for every 10 years starting at age 65 years through age 95. In addition, the respondents provided a self-rating of health on a seven-point scale (1 = *Very poor* to 7 = *Very good*) which we convert to a binary variable indicating low health (responses of 1-5) and high health (6 and 7). The respondents also completed an 8-item measure of numeracy (Weller et al., 2012); the resulting numeracy variable represents the number of items answered correctly. In an earlier study, Elder (2007) presents some data suggesting that there is an association between cognitive ability and reported life expectancy, with those with higher cognition scores providing more accurate assessments of survival rates. However, the cognitive measures used in the HRS, such as asking “Who is the President of the United States?” are limited in scope. Thus, in the present study we use the better calibrated, 8-item measure of numeracy by Weller et al., 2012 to test this possible relationship.

Results

We organize the results as follows: First, we present an analysis like that in study 1 on the effects of live-to and die-by frames on the life expectancy judgments with a special focus on the effects of personal information, e.g., self-reported health status on life expectations. Second, we again compare the life expectation judgments from this study to the average life expectancies for men and women taken from the 2006 SSA life expectation tables, and also explore the effects of self-reported health status.

<u>Life Expectations</u>. Again, for ease of comparison, all of the life expectancy estimates are given in terms of the reported probabilities of living to age X or older. Also, for ease of analysis we use the likelihood judgments of living to age 85 as our main dependent variable along with the Weibull estimated mean life expectancy. The effect of the live-to or die-by framing clearly replicates, as seen in a comparison of Figure 2a and Figure 2b.

On average, individuals in the live-to frame judged their probability of being alive at age 85 to be 52%, whereas those in the die-by frame judged their probability of being alive at 85 to be 30%. As with the previous study, there was an approximately ten-year gap in the median expected age of death. An analysis of estimated mean life expectancy per respondent, calculating using the Weibull estimation method described in study 1, shows that framing, subjective health, and gender all have significant effects on average life expectancy, consistent with the findings for the probability estimates (see Table 1 for results). Framing again has the largest effect, with the live-to frame adding approximately 7.4 years to an individual's estimated mean life expectancy; this is a significantly larger effect than gender, for example, which adds 2.5 years. Importantly, the self-reported rating of health was significantly, and positively, related to life expectations. Numeracy, on the other hand, was not found to have a significant effect on the judged probabilities. Nor was there evidence of an interaction between numeracy and framing in determining beliefs about life expectancies.

Relationship between Life Expectation Judgments and Social Security Data. The analyses presented above again demonstrate that the life expectancies provided by the respondents reflect factors that impact actual life expectancies, e.g., the gender of the respondent. Next, we extend those analyses by comparing the judgments made by each respondent for each target age with the life expectations in the 2006 SSA Life Tables.

Figure 3 presents the judged probability of living minus the SSA estimated probability of living, first by frame (Figure 3a) and then by gender and self-reported health status (Figure 3b), for each target age. Again it is clear that frame has a significant effect on the average difference score, with individuals in the live-to frame overestimating their chances of living to each age (t = 7.85, t = 9.08, and t = 8.62, for ages 75, 85, and 95, respectively, all $p < .001$). Over or under estimating again varies significantly depending on the age being predicted; for age 75, the mean difference is a negative 12.02 years ($p < .0001$), whereas for age 95, the mean difference is a positive 13.8 years ($p < .0001$). A regression of the mean difference at age 85 finds that in addition to the significant effect of framing ($\beta = 21.0$, $p < .001$), gender ($\beta = -4.4$, $p = .05$) and health ($\beta = 17.7$, $p < .001$) are also significant predictors of the difference between subjective probabilities and actuarial estimates. An examination of Figure 3a also indicates that there was less discrepancy between the judged life expectancies and the SSA data for judgments in the live-to frame for the younger target ages, i.e., 65 and 75, whereas the discrepancy was smaller for die-by judgments at the oldest target age (95).

Insert Figure 3 about here

To summarize, the judged life expectancies by nearly two thousand respondents in Studies 1 and 2 showed a large effect of the question frame on how long a person expects to live. In addition, factors that actually affect longevity, such as the age, gender, and self-reported health status of the respondent, were shown to have predictable effects on the judged life expectation. The influence of both an irrelevant factor (attribute frame) and relevant factors (age, gender, health status) is consistent with the hypothesis that beliefs (expectations) about how long one might live are a response constructed at the time of judgment. It is worth stressing that a constructed belief perspective does not imply that valid information is not used in making a probability judgment. Rather it implies that a constructed response will often reflect selective attention to information. In the next study we more directly investigate the cognitive process that may underlie the differences in life expectancies due to a live-to or die-by frame.

Study 3

Study 3 directly investigates whether the framing differences in responses are related to the relative accessibility of different types of information used in constructing the judgments. In particular, we adapt a technique based on Query Theory (Hardisty, Johnson, & Weber, 2010; Johnson, Häubl, & Keinan, 2007; Weber et al., 2007) to examine whether different frames impact the types of thoughts people have about living to a certain age. Query Theory suggests that in order to arrive at a constructed preference or judgment, people ask themselves a series of internal, and implicit, queries. These queries are asked serially, beginning with arguments in favor of the default option (e.g., living to age 85 *or* dying by age 85). Because of output interference, early thoughts inhibit later thoughts. Thus, the balance of thoughts supports the default option and preferences or judgments are biased toward the default option. In study 3, we test whether frame (live-to vs. die-by) leads to differences in the number of thoughts in favor of living to age 85 (e.g., "with today's medical advances I think it will be possible to live to that age very easily") and the number of thoughts in favor of dying by age 85 (e.g., "I dont [sic] want to get that old, it'd be too much on my body") and whether these differences predict the judged probability of living to age 85. Specifically, we expect participants in the live-to frame to have relatively more thoughts in favor of living to age 85 than participants in the die-by frame and we expect this difference to lead to a greater judged probability of being alive at age 85 for participants in the live-to frame.

In addition, Study 3 investigates whether the strong framing effect found in the first study replicates if the live-to or die-by questions are asked using a different, more open-ended, response format. The more open-ended format is similar to that used by Fischhoff et al (2000) in their study of life expectancies for teenagers. While it may impede direct comparison with estimates from the previous two studies, we believe that finding the same framing effect with a different response mode will help generalize the effect.

Participants

U.S. residents were recruited and run online through an online university-maintained paid panel. Participants (N=350) who passed an attention filter, gave coherent probability judgments (i.e., judged that they were less likely to be alive at 95 than at 65), and completed all parts of the study were compensated $4 for their time. Seventy-one percent were female, with a mean age = 40, SD_{age} = 12.79. Note, the mean age was more than 10 years younger in this study than in the previous two studies.

Method

In a between-subjects design, participants were randomly assigned to the live-to or die-by framing condition. After doing a warm-up task to familiarize themselves with the thought-listing software, participants were prompted to report any thoughts that went through their minds as they considered the probability of living to [dying by] 85 years old or older [younger]. They listed these thoughts one by one using a type-aloud protocol (Johnson et al., 2007; Weber et al., 2007). After recording their thoughts, participants indicated how likely they thought it was that they would live to [die by] ages 65, 75, and 85 years old using a fill-in-the-blank format. Participants then coded each of their own previously-listed thoughts along two dimensions. First, participants coded each thought as being more about life and/or living, more about death and/or dying, or neither. Second, participants coded each thought as being positive, negative, or neither. As an example, the statement "Because of modern medicine, I won't die at the age of my parents" would be coded as being about dying but positive (see Weber et al., 2007, for discussion of evidence that coding by participants and coding by raters who were not participants yield similar patterns of results). Lastly, participants reported demographic information, including their perceived current health. In this study we adapted a slightly different 5-point scale (1 = *poor* to 5 = *excellent)* from the Health and Retirement Survey to be able to test more than one measure of health status; for analysis, health is again separated into a binary variable of low health (1-3) and high health (4 and 5).

Results

Again, for ease of comparison, all of the life expectation estimates are given in terms of the reported probabilities of living to age X or older. Once more we find a highly significant effect of question frame on life expectancies ($F(1, 348) = 74.80$, $p < .001$). For the target age of 85 used in the thought listing task, the probability of living to age 85 was 57% in the live-to frame and only 33% in the die-by frame, a highly significant difference due to framing, $t(347.9) = -8.88$, $p < .001$. Thus, the strong effect of framing on life expectancies does not depend upon the response scale used in studies 1 and 2.

We again conducted a regression of the estimated probability of living to age 85 with framing, age, gender, and subjective health as independent variables. Framing and subjective health were highly significant predictors of life expectancies ($p < .001$). Age and gender were only marginally significant ($p < .10$) in this analysis, suggesting that personal information about subjective health may be more predictive of subjective longevity judgments than more public information, as suggested by Hurd (2009). Regression of mean life expectancies, calculated using the same Weibull estimation method as in study 1, however finds positive effects for all variables: frame, gender, and health are all significant predictors of mean life expectation, with the live-to frame adding an additional 8 years to mean life expectations. The coefficients and standard errors for this regression are provided in Table 1.

As in study 2, we compared respondents' subjective probabilities to their actuarial probabilities from the 2006 SSA life tables, matched by age and gender. Frame again had a significant effect on the average difference score: the live-to frame resulted in overestimates for each age (t = 6.15, t = 7.51, and t = 3.81, for age 75, 85, and 95, respectively, all $p < .001$). In addition, subjective probabilities were significantly underestimated for age 75 (mean difference = -9.49 years, $p < .0001$), significantly overestimated for age 85 (mean difference = 3.73 years, $p < .004$), men significantly overestimate more than women (for age 85, t = -2.52, p = .01), and those with better self-reported health overestimate significantly more than those with worse self-reported health (for age 85, t = 5.18, $p < .001$). Thus, all of the results above provide one more replication of the basic pattern of life expectancy judgments presented earlier for studies 1 and 2.

We now turn to understanding the relationship between the thoughts reported during the task and predicted life expectation. Recall that we suggest that differences in the estimated live-to and die-by ages are due to differences in what is retrieved from memory in the two conditions. Across conditions, respondents listed between 1 and 27 thoughts (M = 3.75, SD = 2.66) related to the probability of living to (or dying by) age 85. We looked at thoughts in favor of living to age 85 (thoughts coded as being about life/living and positive) versus thoughts in favor of dying by age 85 (thoughts coded as being about death/dying and positive).[iii] Overall respondents listed significantly more thoughts in favor of living to age 85 (M = 1.71, SD = 2.12) and fewer thoughts in favor of dying by age 85 (M = 0.08, SD = 0.34, $t(345)$ = 14.15, $p < .001$).

We first checked whether there were differences in the kind of thoughts reported in the two frames. Looking at the difference score (number of thoughts in favor of living to age 85 minus the number of thoughts in favor of dying by age 85), respondents in the live-to frame (M = 2.02, SD = 2.42) had relatively more thoughts in favor of living to age 85 than respondents in the die-by frame (M = 1.20, SD = 1.70, $t(344)$ = 3.62, $p < .001$). This suggests that the two frames result in different retrieval and consideration of information from memory.

Next, we explore whether the thoughts listed were related to estimated longevity. The relative number of thoughts in favor of living to age 85 (a standardized difference score) was significantly related to the judged probability of living to age 85 or longer (B = *9.07*, SE = 1.39, $t(344)$ = 6.52, p < 001). In other words, the more respondents emphasized the positives of living to age 85, the more likely they thought it was that they would live to age 85.

Finally, we want to explore whether the differences in the relative number of thoughts in favor of living to age 85 could account for the framing differences. To do so, we ran a Preacher-Hayes bootstrap test on the data to test for mediation (Preacher & Hayes 2004, Zhao, Lynch, & Chen 2010). The mean indirect effect from the bootstrap analysis was positive and significant (adding 1.12 years to life expectancy), with a 95% confidence interval excluding zero, indicating that the thoughts mediated the relationship between frame and life expectancy. In the indirect path, changing the frame from "die by" to "live to" increases the difference between about life and about death thoughts by .271, while holding constant frame, an increase of one thought about life, relative to death, increases life expectancy by 4.12 years. While the mediation effect is significant, the proportion of the total effect that is mediated is 4.7%, and the direct effect of frame on life expectancy (22.7) continues to be positive and significant ($p < .001$). This suggests that relative number of thoughts does contribute to framing's effect on life expectations but that there may also be additional process mediators that could also be explored.

To summarize, three studies totaling over 2300 respondents demonstrate that subjective life expectancies differ contingent upon whether respondents are asked to provide probabilities of **living to** a certain age or older or are asked to provide probabilities of **dying by** a certain age or younger. Consistent with these effects, live-to framing also significantly increases both optimism relative to SSA life tables and modeled mean life expectations. This constructed belief perspective is reinforced by our mediation analysis which suggests that respondents had more positive thoughts about being alive at 85 years old in the "live-to" condition than in the "die-by" condition, and this in turn, predicted subjective probabilities of being alive at age 85. Thus, it seems that judgments of an important future event, for which individuals should have significant amounts of private information, may be "constructed" responses with predictable biases in the subjective probabilities of longevity. To further test the validity of the assessed life expectations, we now turn to two sets of data that explore whether the expressed probabilities of living to (or dying by) certain ages are related to stated preference for purchasing a life annuity. An examination of the relationship between the judged life expectancies and preference for life annuities provides another test of the validity of the assessed life expectations.

Relationship to Preference for a Life Annuity

One of the most important financial questions individuals (and households) face in making decisions about how to generate income from their accumulated retirement funds is what percentage, if any, of these assets should be allocated to the purchase of some form of a life annuity. Contingent upon an immediate payment of a certain amount, a standard immediate life annuity guarantees a specified level of income as long as one lives, eliminating the possibility of outliving one's income. Life annuities have been described as longevity insurance, guaranteed lifetime income, or a "safety net" of income for later in life. Life annuities also generally pay more out each month than many investment options due to a "mortality" premium. The company issuing the standard life annuity keeps your payment even if you die soon after purchasing the annuity.

There are strong economic arguments for at least partial annuitization of one's retirement savings (Yaari, 1965; Davidoff, Brown, & Diamond, 2005). However, there is only mixed evidence for the voluntary purchase of single premium life annuities by consumers. This has been termed the "annuity puzzle." The most often mentioned downside of an annuity purchase is the potential for early death and the consequent loss of principal with no benefit to one's estate (i.e., the bequest motive). Obviously, therefore, the sooner you expect to die, the less attractive an annuity purchase is. People are often advised to explicitly consider how long they expect to live before making an annuity decision (Goodman & Heller, 2006).

To test the relationship between life expectancy and annuity preference, half of the participants in study 2 (N = 197) reported the likelihood that they would purchase a life annuity after having made their life expectancy judgments. See Figure 4 for a picture of the task used. The exact wording used in the single life annuity and the subjective life-expectancy tasks were consistent (live-to or die-by). Although the expressed annuity preference in this study is hypothetical, recent research done with other online panels has found that responses to expected retirement behavior are strongly and positively correlated with actual behavior (Brown, Kapteyn, & Mitchell 2011).

Insert Figure 4 about here

Overall, participants did not express a preference for purchasing a life annuity (consistent with much of the prior work on annuity preferences). The average purchase probability was 33%. The distribution of responses also was highly skewed with the mode being 0% probability of purchase.

Importantly, as would be expected if the life expectancy judgments expressed were valid, the attractiveness of an annuity product increased the longer one expected to live (β=.67, t=4.23, $p < .0001$). To illustrate this effect, the average likelihood of purchasing for those who judged themselves more likely to live longer (identified by median split) was 39% whereas the average likelihood of purchasing for those who judged themselves less likely to live longer was 26%. A closer inspection of the data, however, finds that this effect is strongest for individuals in the live-to framing condition (β=.92, t=4.44, $p < .0001$). This may suggest that framing has an effect not only on life expectancies but also on how those life expectations are incorporated into decisions about future financial outcomes, with individuals in a live-to frame expressing higher sensitivity to their life expectancy estimate.

In a follow-up study to study 2, half of 677 respondents were asked to indicate their preference for an annuity before completing the life expectancies task and half after completing the life expectancies task. While the order of tasks did not significantly affect life expectancies nor the strong framing effect, participants who completed the life expectations task first were more likely to choose annuities over self-management (56%) than those who did the life expectations task second (48%, $p < .05$), suggesting that first thinking about life expectancy can indeed increase interest in annuities. More generally, it is clear that the individual differences in life expectancies carry forward to individual differences in stated preference for life annuities, a product that provides insurance against outliving one's savings, and that completing a life expectation task before stating a prefer for a life annuity <u>may</u> increase the attractiveness of an annuity purchase.

Discussion

The results of the present studies demonstrate that subjective probability judgments of life expectancies, a clearly important future event for which a person should have significant personal information, may be "constructed" in the sense that the judgment is subject to predictable biases such as how the event is framed. Participants asked for life expectancies framed as a "live to" prediction provided higher probabilities across all age ranges than those asked about "die by". The differences between the estimates are seen most clearly when one considers where each line crosses 50%; for the "live to" condition, this occurs around age 85, whereas for the "die by" condition this occurs at age 75. This 10 year difference in the median expected age of being dead or alive is not only statistically significant but also highly meaningful to a number of important life decisions such as how to finance one's consumption during retirement.

A more constructed perspective on preferences and beliefs may seem discouraging to those trying to measure consumers' preferences and beliefs. Prediction of individual differences in behavior no doubt becomes more difficult, particularly in terms of estimating exact parameter values. However, Payne, Bettman, and Schkade (1999) offer some initial suggestions on how to improve prediction of values in a world of constructed preferences. Some of those suggestions are easily applied to improving prediction in a world of constructed beliefs or probabilities. It is also encouraging that although the mean probabilities assessed for the different ages did differ in the two frames (live-to and die-by), the individual differences in expectations in both frames were shown to relate individual differences in purchase intentions for life annuities, a product that provides insurance against outliving one's savings.

One example where constructed preferences and beliefs can directly affect attempts to model a consumer's optimal consumption is with the Life-Cycle model (see Browning & Crossley, 2001). The Life-Cycle model assumes that consumption differences between consumers can be measured in each of three task components: utility of consumption at any given point in time, willingness to tradeoff consumption over time, and expectations for reaching different consumption times in the future. The general view assumes that these utilities, time preferences, and expectations are stable individual differences that could be used to predict a wide range of complex financial decisions. Even recent research that has modified the Life-Cycle model, such as theories that include reference values (Browning & Crossley, 2001) and present bias (Angeletos, Laibson, Repetto, Tobacman, & Weinberg 2001), continue to assume stable individual traits. What happens, however, if the utilities, time preferences, and expectations reflect constructed as well as revealed values and beliefs? Utilities can depend on whether outcomes are framed as gains or losses, time preference can change by “framing the future first” (Weber et al., 2007), and the work presented here shows that the judged probabilities of reaching future ages are also subject to a substantial framing effect. While our current work focuses on understanding how biased expectation judgments can influence preference for annuity products, many other decisions that arise out of the Life Cycle model (such as how and how much to save for retirement, when to retire, and how much insurance to buy) will also be affected by these cognitive biases.

On a positive note, the constructed process viewpoint of preference and belief formation opens up new approaches for improving consumer decision making. For instance, there is now clear evidence of the power of default options in a variety of preference problems. In addition, process interventions as well as the improved design of decision environments may be seen as more promising. For example, in our follow-up study described earlier, we find evidence that preference for a life annuity might change contingent upon the order of which life expectancy judgments are elicited. The order of tasks is one process element of a “Choice Architecture” (Thaler and Sunstein, 2008). Finally, the results reported in all studies on the comparison of subjective probabilities to SSA data suggest that accuracy for life expectancies might be improved if the judgments about “young old” ages (e.g., 65 and 75) were asked using a live-to frame and judgments about “old old” ages (e.g., 85 and 95) were asked using a die-by frame. Thus, the results presented above can be seen as contributing to the literature on framing effects and constructed beliefs and preferences more generally. The results also have implications for the design, and interpretation, of surveys asking life expectation questions. Finally, there is a growing recognition that “biases” in judgments and choices can be used to perhaps improve decision making. Obviously the latter is speculative in terms of the present tasks but is one direction for future research.

Future Research

As mentioned above, the results presented here have immediate implications for researchers who wish to collect individuals’ judgments about future beliefs by encouraging caution in selecting the relevant frame. As shown in our analysis of over and under estimation of life expectancy relative to actuarial data, systematic misestimation may result from a particular choice of frame which then has real implications for any researchers or individuals relying on the resultant judgment. This is true for any inter-temporal decision that requires the decision-maker to have some beliefs about the probabilities of future events that are pertinent to the decision (Manski, 2004). For example, it would be worthwhile to see if life expectancies elicited by different frames or in different orders lead to differences in the willingness to delay claiming of Social Security benefits (Brown, Kapteyn, &Mitchell, 2011). As another example, in deciding the type of mortgage one might want to finance the purchase of a home, a consumer should consider how long he or she expects to live in the house being purchased. It would be interesting to see if framing effects like those studied here extend to subjective expectancies related to mortgage choices. It would also be interesting to extend the framing and life expectancies task to other consumer decisions. For example, people often accumulate products today, e.g., bottles of wine, with the expectation that they will be able to consume those products sometime in the future. At what age should (do) consumers change their acquisition patterns (amount and type of product) as a function of life expectations? Finally, Manski (2004) and Hurd (2009) argue that research needs to continue on the properties of subjective probabilities of events such as longevity, including how those important subjective probabilities are formed. Obviously, we agree. While we do find that the relative number of thoughts does contribute to framing's effect on life expectations there is much more research needed on the process mediators of judgments about life expectations.

Conclusion

In a recent opinion editorial in the New York Times, Hu and Odean (2/25/2011) state that "anyone planning for retirement must answer an impossible question: How long will I live?" Although this question may be a difficult one to answer, people do not behave as if it is an impossible one. Along with a number of other surveys, including the Health Retirement Survey, we show that people are capable of providing probability judgments of living to various ages that track SSA data on life expectations and seem to reflect personally held information such as assessments of one's health status relative to others. The market for products like life annuities also seems to believe this is not an impossible question to answer, as evidenced by concern in that market about adverse selection (i.e., people who correctly judge themselves as more likely to live longer being more likely to purchase a life annuity). Nonetheless, it is also clear that life expectancies may exhibit systematic motivational biases as well as random error. For example, people seem to be more optimistic about their life expectancies for later target ages such as 85 and 95. In this paper we go beyond motivational biases and provide evidence that argues for a more cognitive "constructed process" perspective in future research on the formation of beliefs about longevity. Exactly how you ask the longevity question (live-to or die-by) impacts the accessibility of thoughts related to the construction of the probability judgments and can lead to systematic, and meaningful, differences in judgments regarding how long one expects to live.

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Appendix A: Description of Weibull estimation procedure, including ability to calculate estimated value of annuity per respondent

Given that we had collected a series of survival probabilities for each participant at a sequence of specific ages, we wished to use this data to calculate a mean life expectancy per individual. A commonly used distribution in survival analysis is the Weibull function, which has desirable properties of being relatively flat in early years but then yields an increasing failure rate with increasing age, consistent with human aging patterns. The cumulative distribution function of the Weibull, which can be interpreted as probability of failure (death) at age x, is given as:

$$F(x) = 1 - e^{-\left(\frac{x}{\alpha}\right)^{\beta}}$$

However, since our data are coded as probability of living at any age x, we use 1 – *F(x)* in our estimates and the equations below.

We start with the series of probability estimates p_{ij} for participant *i* where x_j represents the age for which the estimate was collected. In all of our studies, we collect probability estimates for ages 65, 75, 85, and 95; for some studies, we also collect estimates for age 55. We also have the participant's current age, age_i. We then assume that these probability estimates are consistent with the Weibull function in the following manner:

$$p_{ij} = e^{-\left(\frac{x_j - age_i}{\alpha_i}\right)^{\beta_i}}$$

where α_i and β_i are the Weibull distribution parameters specific to that particular individual. The p_{ij} values per participant, along with the current age, provide us with enough data points to estimate α_i and β_i per individual. Furthermore, to "cap" the survival function at a reasonable upper bound, we assume p_{ij} = 0% at age x_j = 130 years. We selected age 130 as the upper bound based on the longest documented human lifespan: Jeanne Calment of France, who died at more than 122 years old. Given that many participants in our studies have grown up in a time of significant health and medical advances, it is not unreasonable to expect that some of them may make it to 130.

To estimate the Weibull parameters, we rearrange terms and perform log transforms to get the following linear expression:

$$\ln(-1 * \ln(p_{ij})) = -\beta_i * \ln(\alpha_i) + \beta_i * \ln(x_j - age_i)$$

We can now do a regression with the left hand side expression as Y and $\ln(x_j – age_i)$ as X, which provides us with a constant and a coefficient per individual. Putting these estimates back into the expression above allows us to solve for α_i and β_i. Finally, to get mean expected age per individual, we set p_{ij} = 50% and solve for *x*, which gives:

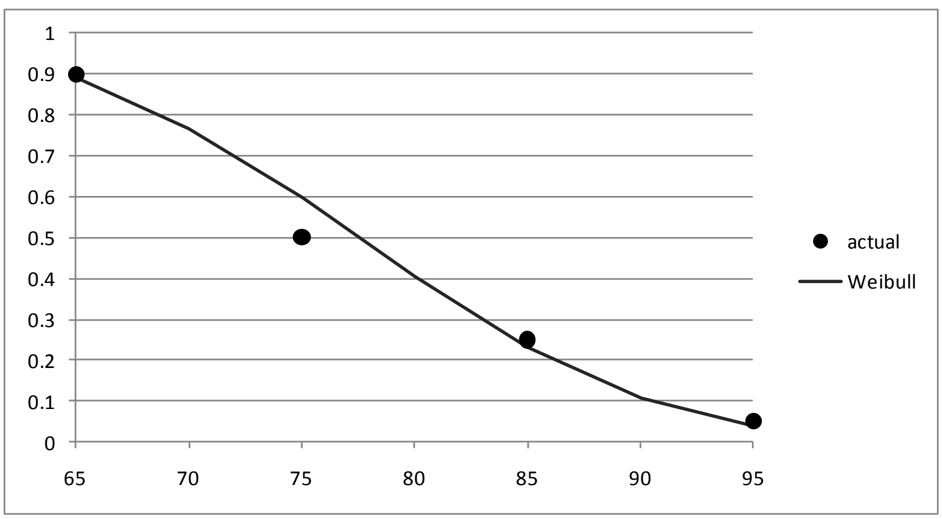
$$mean\ expected\ age = \ age_i + \ \alpha_i * (-1 * \ln(0.5))^{\frac{1}{\beta_i}}$$

We can also use the Weibull estimates to generate the expected value of an annuity for each individual. To do so, we need to calculate the area under the curve for the Weibull function, per individual, for the years from age 65 until death (infinity). This integral comes out as:

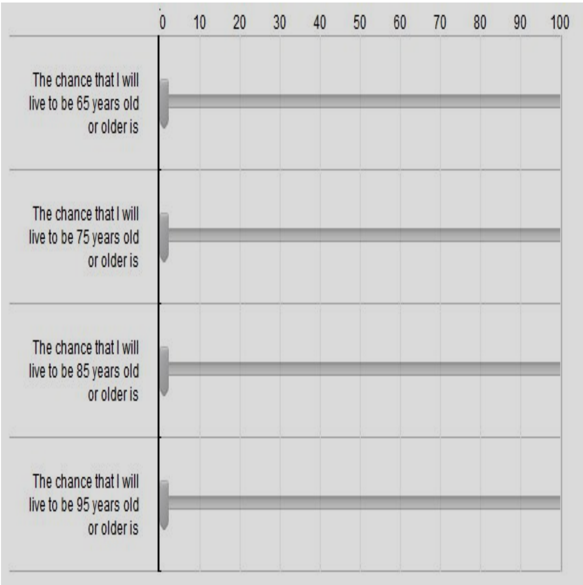
$$\int_{65}^{\infty} e^{-\left(\frac{x}{\alpha}\right)^{\beta}} dx = \frac{\alpha\left(\Gamma\left(\frac{1}{\beta}, \left(\frac{65}{\alpha}\right)^{\beta}\right)\right)}{\beta}$$

where Γ is the Gamma function. The result of this calculation can then be multiplied by the per period value of the annuity; for our analysis, we use an annual value of $6,800 to be consistent with our survey stimuli.

As an example of this procedure, consider the data provided from one of our participants in Study 2. This individual provided estimates of 90% chance of being alive at age 65, 50% chance at age 75, 25% chance at 85, and 5% chance at age 95. To this list, we include a 0% chance at age 130. This participant's current age was 47. Using the procedure outlined above, we estimate α_i = 34 and β_i = 3.4. The graph below shows the plot for the resultant function along with the original estimates from the participant. Using this function, the mean expected life expectancy for this individual is 77.6 years, and the expected value of the annuity that starts at age 65 is $87,485.



Figures 1 a and 1b



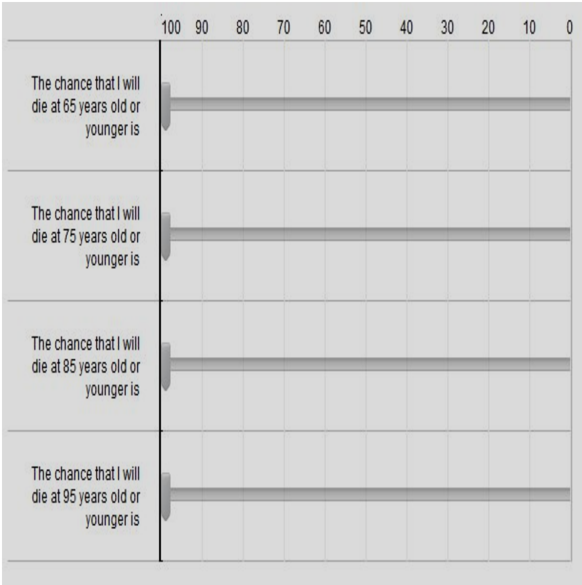


Figure 2 a

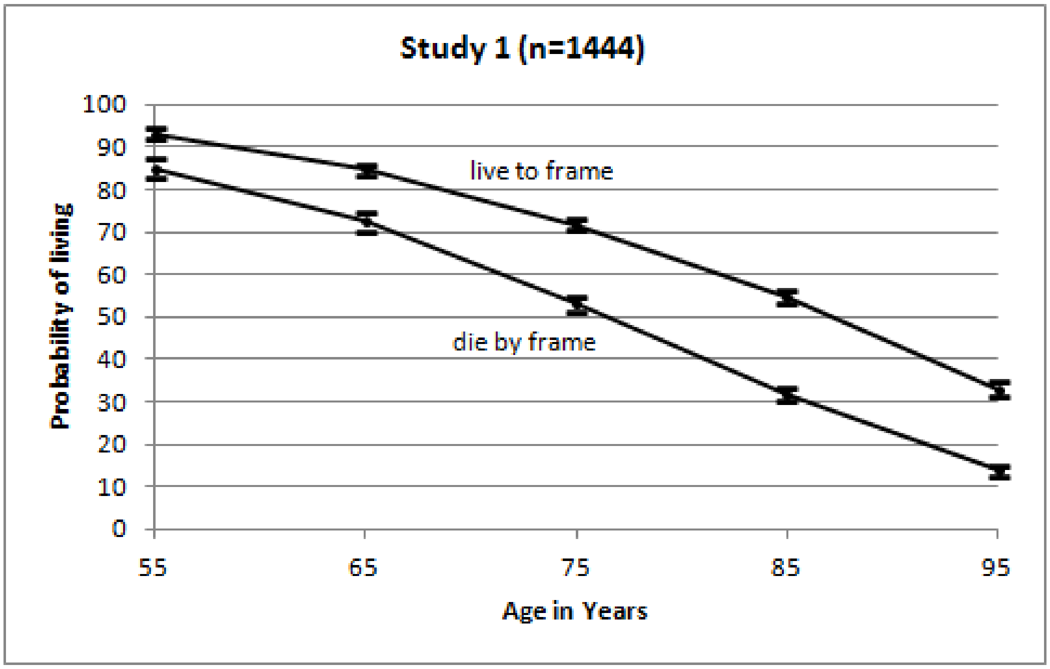


Figure 2 b

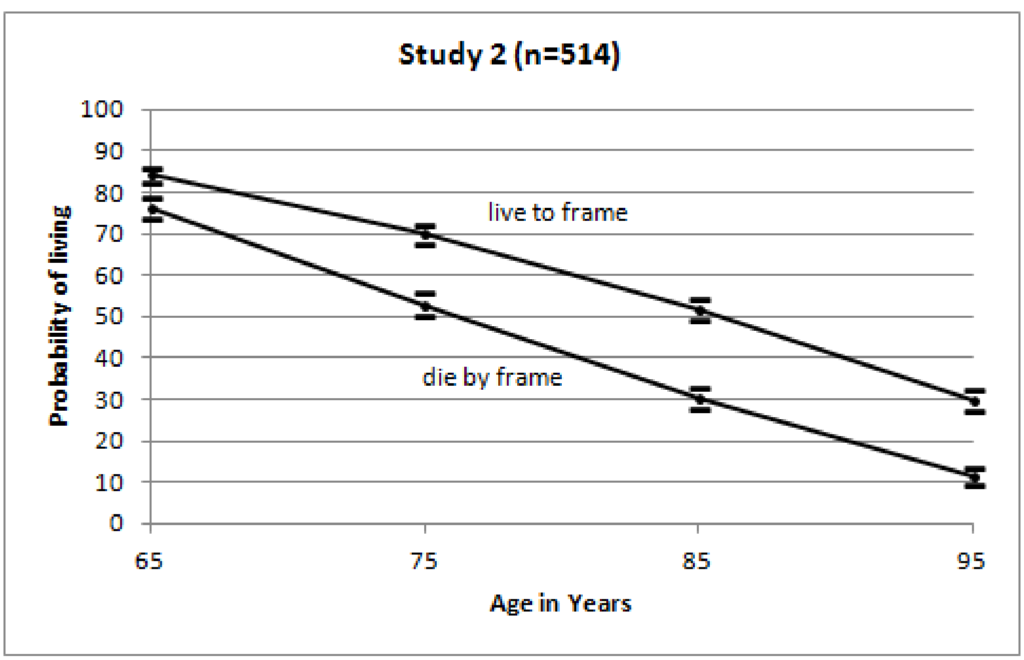
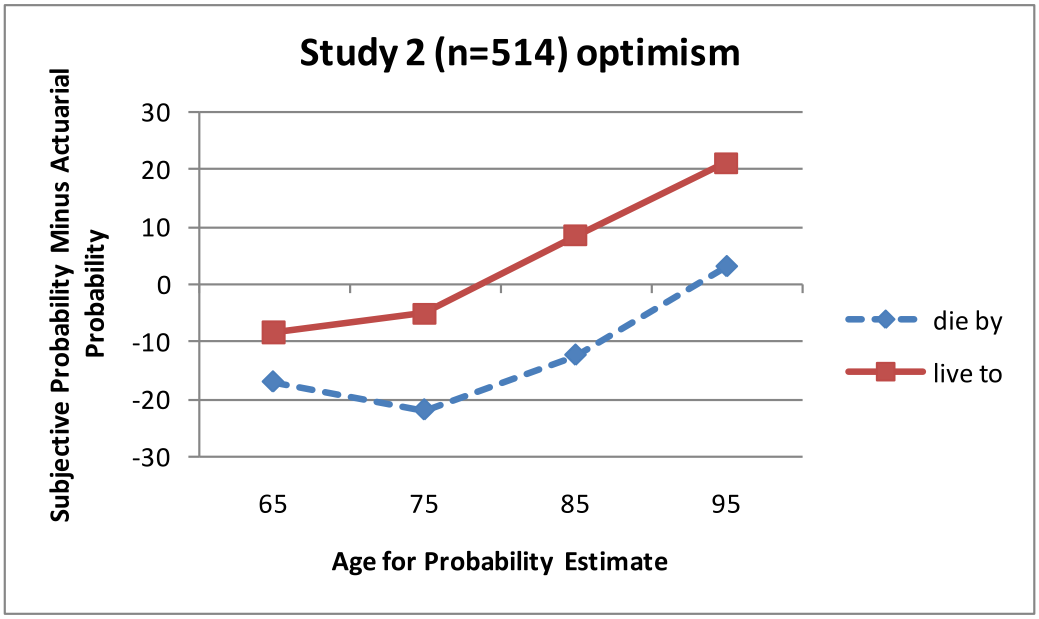


Figure 3a, b


Study 2 (n=514) optimism
Subjective Probability Minus Actuarial Probability
30
20
10
0
-10
-20
-30
65
75
85
95
Age for Probability Estimate
die by
live to

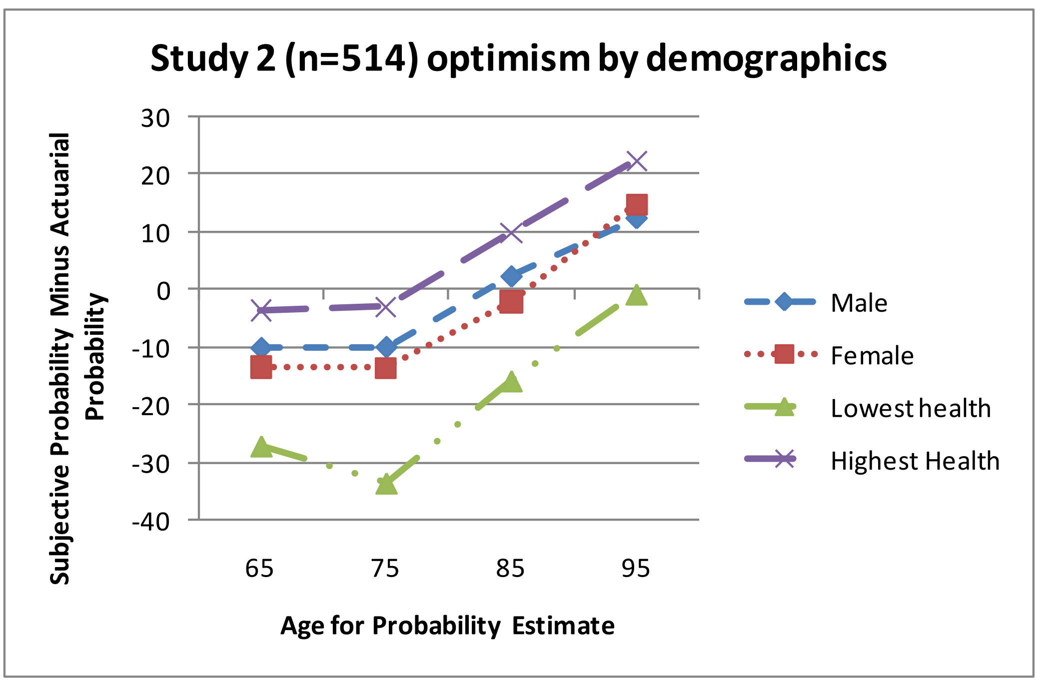

Study 2 (n=514) optimism by demographics
Subjective Probability Minus Actuarial Probability
30
20
10
0
-10
-20
-30
-40
65
75
85
95
Age for Probability Estimate
Male
Female
Lowest health
Highest Health

Figure 4

Example of the Purchase Probability Task

Age = 65, single life annuity income to you, per $100,000 investment amount

Guaranteed amount paid each year you live starting at age 65	$6,800	Total amount paid each month	$567	Guaranteed return percentage paid each year	6.8%

Note: no payment to heirs when you die. Any amount not paid to you remains with the insurance company.

The total cumulative payments made to you up to different ages based on a payment of $100,000 at age 65.

Age	70	75	80	85	90	95	100
Amt. paid if Live to age	$34,000	$68,000	$102,000	$136,000	$170,000	$204,000	$238,000

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Definitely No — Maybe No / Maybe Yes — Definitely Yes

Table 1
Determinants of mean life expectations - Studies 1, 2, and 3

	Study 1 N = 1444 **Ages 18 to 83**	**Study 2 N = 514** **Ages 45 to 65**	**Study 3 N = 350** **Ages 18 to 73**
	Dependent variable: **Mean life expectation**	**Dependent variable:** **Mean life expectation**	**Dependent variable:** **Mean life expectation**
Constant	66.59***	64.6***	73.59***
	(1.21)	(1.93)	(.97)
Framing	9.17***	7.38***	8.01***
	(.69)	(.97)	(1.00)
Age	.138***	.12	.029
	(.02)	(.09)	(.04)
Gender (male)	-1.08	-2.5**	-1.85*
	(.70)	(1.00)	(1.10)
High health	NA	7.49***	5.00***
		(.96)	1.01)
Numeracy	NA	.18	NA
		(.26)	

Notes: Reports the coefficients from OLS regressions. Standard errors are in parentheses.

Age is mean-centered at age 51 for Study 1.

Age is mean-centered at age 56; high health indicates responses above 5 on a 7-point scale for Study 2.

Age is mean-centered at age 40; high health indicates responses above 3 on a 5-point scale for Study 3.

*** Significant at the 1 percent level

** Significant at the 5 percent level

* Significant at the 10 percent level

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[ii] Examples where judged probabilities for two complementary hypotheses sum to less than one have been documented in other judgment tasks; see Brenner, Koehler and Rottenstreich (2002) for a review and a description of how asymmetric support theory can be used to explain these violations of binary complementarity.

[iii] Thoughts coded as negative and about life/living or death/dying were not clearly in favor of living to or dying by, respectively, age 85. However, we find the same pattern of results if we incorporate negative thoughts into our analysis (i.e., grouping thoughts coded as about life/living and positive or about death/dying and negative together as thoughts in favor of living to age 85 and grouping thoughts coded as about death/dying and positive or about life/living and negative together as thoughts in favor of dying by age 85).