Time preferences for the very long term

Gretchen B. Chapman *

Psychology Department, Busch Campus, Rutgers University, 152 Frelinghuysen Road, Piscataway, NJ 08854-8020, USA

Abstract

Many important decisions concern outcomes delayed by decades or centuries. Whereas some economists have argued that inter-generational discount rates should be lower than intra-generational rates, three experiments found that inter- and intra-generational discount rates were quite similar. Experiment 1 found that discount rates for long delays (30–900 years) were lower than those for shorter delays (1–30 years) but that, holding delay constant, discount rates for outcomes occurring to future generations were similar to those for outcomes occurring to the present generation. Experiment 2 compared inter-generational discount rates for three different types of outcomes and found similar discount rates for saving lives, improving health, and financial benefits. Experiment 3 found similar inter-generational discounting of life-saving programs that benefit people close to or distant from the decision maker. These studies indicate that the discount rate applied to outcomes occurring to future generations depends on the length of the time delay but not on other factors. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Many decisions involve trade-offs between outcomes that occur in the short term and those that occur in the long term. These decisions are influenced by the decision maker’s time preferences, or the extent to which future outcomes are valued relative...
to immediate ones. Most research on the psychology of time preferences has focused on decisions that occur on an individual level (e.g., Benzon, Rapoport & Yagil, 1989; Chapman, 1996; Chapman & Elstein, 1995; Loewenstein & Thaler, 1989; Thaler, 1981). For example, individuals choose between getting a flu shot now, or having a higher risk of influenza over the next several months (Chapman & Coups, 1999), or choose between a small record store gift certificate now or a larger certificate several weeks from now (Loewenstein, 1988). These decisions involve relatively short delays.

Many of the most important inter-temporal choices, however, involve outcomes that are delayed not by weeks, months, or years but rather by decades and generations. These inter-temporal choices often occur on a societal level. For example, public health officials may decide whether to incur the short-term financial costs of vaccinating newborns against hepatitis in order to gain the delayed benefits of lower disease prevalence when the infants mature. Some social inter-temporal choices involve explicit trade-offs between different generations. For example, the present generation must decide how much cost to incur in preventing global warming, reducing air pollution, and preserving the rainforests so that future generations can benefit from these actions. Such decisions involve not only preferences for outcomes at different points in time but also questions of inter-generational equity. The current paper examines how inter-generational time preferences differ from the more-researched individual time preferences.

1.1. Inter-generational time preferences

A number of researchers have argued that, normatively, inter-generational temporal discount rates can or should differ from intra-generational rates. Lipscomb (1989), for example, distinguished between two types of time preferences. The first is an individual’s preference for the timing and ordering of events in their own lifetime. The second type is involved in decisions where present and future cohorts are vying for resources and a decision maker must establish a relative social weighting of cohorts. Lipscomb argues that, normatively, in discounting of future cohorts, the discount rate should equal the real interest rate, thus ensuring that all generations are valued equally. In contrast, for decisions about outcomes that occur within a cohort, discounting should be based on individual decision makers’ subjective time preferences, and these time preferences need not conform to any particular normative model. Lipscomb’s empirical study addressed only individual, not inter-generational time preferences, since he argues that only the former is an empirical issue.

Cropper and Portney (1990) also distinguish between intra-generational and inter-generational discount rates and argue that the intra-generational discount rate should be the consumption rate of interest. Since the inter-generational discount rate reflects how later generations are weighted relative to earlier ones, Cropper and Portney argue that this discount rate should be the rate of return on capital reflected in alternative uses for the funds spent on the lifesaving intervention (for example, investing the funds). This inter-generational discount rate could conceivably be zero. Some theorists (Page, 1988) have argued that inter-generational discount rates
should be zero because there is no reason to discount at all at the level of social choice, especially for non-monetary outcomes (Parsonage & Neuburger, 1992, but see Cairns, 1992); however, the issue remains controversial (Krahn & Gafni, 1993). Several theorists (Lipscomb, 1989; Gyrd-Hansen & Søgaard, 1998) have advocated using a combination of individual and societal discount rates.

Sheldon (1992) argues against using discount rates implied by individual preferences as the basis for public sector health care. Individuals may discount the future because of the uncertainty that they will be alive later or uncertainty of the delayed benefit (e.g., if one quits smoking, one may still get lung cancer). These concerns are irrelevant for societal decisions where only the average outcome is relevant and where the time horizon is quite long. In addition, Sheldon argues that positive inter-generational discounting discriminates against future generations because it assigns less weight to future generations than to present ones.

Cropper and Sussman (1990) point out that inter-generational discount problems involve questions of inter-generational equity. Intra-individual discount problems can be answered by the individual herself, according to her own preferences. In contrast, it is unclear whose preferences should be reflected in inter-generational problems. These trade-offs could reflect the altruistic preferences of the present individual, or the preferences of each affected generation, weighted in some ethical way. Cropper and Sussman (1990) propose an overlapping generations model in which each generation receives utility from its own consumption and that of its immediate descendants. As this is true for all generations, all generations are taken into account by the first generation.

1.2. Empirical studies of inter-generational time preferences

Although a number of theorists have put forward the normative view that inter-generational discount rates should be lower than intra-generational rates, few empirical studies have examined inter-generational time preferences or compared descriptive inter- and intra-generational discount rates. Cropper, Aydede and Portney (1992, 1994) conducted a survey of 3000 members of the general public who were asked to choose between two programs, one which saved a specified number of lives now and another that saved more lives but after a 5, 10, 25, 50, or 100 year delay. Median discount rates ranged from 17% for a 5 year delay down to 4% for a 100 year delay. Since the 100 year delay involves trade-offs between generations whereas the 5 year delay does not, this result suggests that inter-generational discount rates may be lower than intra-generational rates. However, the survey question did not explicitly specify which lives saved would be from the present or future generations. Johannesson and Johansson (1996) also assessed time preferences for delayed live-saving programs. The annual discount rate for 20, 50, and 100 year delays was 25%, 12%, and 8%, respectively, somewhat higher than those in the Cropper et al. (1992, 1994) study.

In another study on inter-generational time preferences, Svenson and Karlsson (1989) asked college students, community adults and nuclear power experts how serious an event would be (e.g., leakage of nuclear fuel) if it occurred after a 100, 1000, 2000, 10,000, 100,000, 1 million or 2 million year delay. Thirty percent of
respondents did not discount at all. For those who did, seriousness declined from a rating of 10 to approximately 4 by 2 million years, corresponding to a discount rate of less than $10^{-5}$, assuming participants treated the seriousness ratings as a linear scale. The discount function for a non-nuclear event (epidemic disease) showed an even smaller discount rate. Thus, inter-generational discounting may be quite small.

1.3. Two ways to compare inter- and intra-generational time preferences

To date, research has not explicitly compared intra- and inter-generational discounting. Despite widespread agreement that societal discount rates may (or should) differ from individual discount rates, there have been few suggestions on how to compare the two. Two possibilities exist, depending on whether inter-generational time preferences are thought of as preferences for outcomes that occur many years in the future or as preferences for outcomes that occur to people in a later birth cohort (e.g., adults making decisions on behalf of children).

Delayed outcomes must, by definition, involve either a later generation (or birth cohort) of people or the same cohort at a later age. For example, suppose an immediate life-saving program is compared to a similar program delayed by 30 years. The delayed program could benefit either (a) the same people (now 30 years older) who would benefit from the immediate program or (b) a later birth cohort of people who, at the time of the delayed program, are the same age as the present age of the beneficiaries of the immediate program. In the first case the time delay is confounded with age, while in the second case the time delay is confounded with generation. This age-period-cohort confound is a classic methodological issue in epidemiological research (e.g., Kupper, Janis, Karmous & Greenberg, 1985; Osmond & Gardner, 1989). Since each of the three factors is determined by the other two, conclusions about one factor entail assumptions about at least one of the other two factors.

Past studies of intra-generational time preferences have tended to confound time and age. For example, if I choose between receiving $100 now or $120 in one year, the latter option differs from the first not only in being larger and more delayed, but also in that it will benefit an older person (me, one year older). Since most of these studies involve relatively short delays of several years or less, it is unlikely that considerations of age had a large effect and therefore reasonable to assume that responses reflect time preferences rather than age preferences.

Considering the influence of age and birth cohort on preferences for delayed outcomes is important because there is evidence that these factors influence time preferences. For example, time preferences for lives saved appear to depend on the age of the recipients. Cropper et al. (1994) asked their 3000 survey respondents about their preferences for saving the lives of 60 year-olds vs. those of 20- or 40-year-olds. Responses indicated that the lives of young people were valued more than could be explained by their increased life expectancy. In addition, 20- and 40-year-olds were valued approximately equally, despite their difference in life expectancy, suggesting

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1 To see why this is true, consider the fact that your age now is determined by the year of your birth (cohort or generation) and the current year (time).
that the value of saving a life does not decrease monotonically with age; instead life-saving is valued most highly at an intermediate age (estimated to be in the late 20s). Johannesson and Johansson (1996), in contrast, found no effect of the age of the recipient.

1.4. Comparisons between studies of inter- and intra-generational time preferences

Previous research on inter-generational discounting indicates that discount rates for future generations are often quite low (Cropper et al., 1992, 1994; Johannesson & Johansson, 1996). In contrast, intra-generational discount rates are sometimes very high (e.g., Chapman & Elstein, 1995). Comparisons across studies are difficult, however. Studies of inter-generational time preferences have two features that distinguish them from most studies of intra-generational (or individual) time preferences. First, in past research, inter-generational trade-offs frequently involve life saving events, as opposed to events that alter health quality, finances, etc. Second, inter-generational trade-offs, by definition, involve making decisions on behalf of other people, generally a group of other people. Either of these two features could account for differences in discount rates seen across studies.

Several studies have examined discount rates for saving lives. Horowitz and Carson (1990) conducted a survey of college students which posed choices between an airline safety program that saved 20 lives immediately and a second program that saved more lives following a five year delay. The mean subjective discount rate was 4.5%, quite similar to the market rate of return. In another study, Moore and Viscusi (1990) analyzed labor market data and found subjective discount rates for mortality risks ranged from 1% to 14%. These results suggest discount rates for life-saving outcomes may be quite low, lower than those found in studies of monetary or other outcomes (e.g., Benzion et al., 1989; Thaler, 1981). In a survey of members of the general public and health managers, Olsen (1993) found that discount rates were slightly lower for saving lives (14%) than for health improvements (15%). In contrast, however, Cairns (1994) found higher discount rates for lives saved than for money. Thus, one reason that inter-generational discount rates are so low may be that they involve life-saving outcomes, although the evidence is not clear-cut.

Little research has explored inter-temporal trade-offs made on behalf of a beneficiary. One study (Chapman, 1995) found that decisions made on one’s own behalf involved slightly higher subjective discount rates than those made on behalf of a single beneficiary (54% vs. 45%, $P = 0.07$). Another study (Chapman, 2001) compared two conditions: one in which the participant made a decision on his or her own behalf, and the second in which the participant played the role of a policy maker, deciding on behalf of the constituents of a health insurance company. Discount rates were higher in the first condition (42% vs. 27%, $P < 0.01$). Thus, inter-generational discount rates may be low in part because they involve decisions made on behalf of others.

In summary, comparisons between inter- and intra-generational time preferences cannot be made easily on the basis of existing data. The current experiments make these comparisons while controlling for type of outcomes, type of beneficiary, and age- and cohort-confounds of time delay.
2. Experiment 1

The purpose of Experiment 1 was to compare inter- and intra-generational discount rates to see if inter-generational discount rates really are lower, as some economists have argued they should be. Inter-generational discount rates were compared to intra-generational rates in two ways. In the first type of comparison, inter-generational time preferences were taken to mean those for lengthy delays (such as 100 or 300 years), such that delayed outcome would occur to generations not currently living. Intra-generational time preferences were taken to mean those for shorter delays (such as 1 or 10 years), such that delayed outcomes would occur to members of the current generation. In the second type of comparison, inter-generational time preferences were taken to mean those for delayed outcomes that occur to a later birth cohort whereas intra-generational time preferences were taken to mean those for delayed outcomes that occur to the same birth cohort as do the immediate outcomes. Examples of each type of comparison are given in Section 2.1.

2.1. Method

2.1.1. Participants

The participants were 62 college students who participated as part of a class requirement. Five of these were removed from analysis because they failed to complete three or more of the 11 discounting questions.

2.1.2. Questionnaire

Participants completed an 11-page questionnaire that presented choices between life-saving programs. Each of the 11 pages contained a series of 16 pairwise choices between life-saving programs. Table 1 provides an example of one such choice. Program A always saved 100 lives immediately. Program B saved lives after a delay. Across the 16 choices on a given page, the number of lives saved by Program B was varied from 1 to 1000 (taking values of 1, 25, 50, 75, 99, 100, 101, 105, 110, 125, 150, 200, 300, 400, 500, 1000). Subjects' choices across the 16 pairs indicated their indifference point – that is, the point at which subjects switched from preferring program A to program B. The indifference point was defined as the largest number of lives saved by program B (the delayed program) such that it was not preferred to program A (the immediate program). For example, if someone preferred saving 100 lives now to saving 110 lives later but also preferred saving 125 lives later to saving 100 now, then the indifference point was coded as 110 lives.

Across the 11 pages of the questionnaire, the set of pairwise choices varied in two respects. First, the delay involved in Program B was constant on any one page but

<table>
<thead>
<tr>
<th>Program A. Saves 100 30-year-old people this year.</th>
<th>Program B. Saves 101 40-year-old people 10 years from now.</th>
</tr>
</thead>
</table>

Table 1  
Example trade-off from Experiment 1
varied across pages and took the value of 1, 2, 10, 30, 60, 300, or 900 years. These values were selected because they represented 1, 2, 10, and 30 years as well as 1, 2, 10, and 30 generations, assuming one generation equals 30 years.

Second, the recipients of the delayed program were specified in one of two ways. In the “age” version, the immediate Program A benefited 30 year-olds and the delayed Program B benefited people who were currently 30-years-old but would be older than that at the time the benefits occurred. For example, if Program B was delayed by 10 years then it would benefit 40-year-olds, and if it was delayed by 30 years then it would benefit 60-year-olds. Because of this design, age questions used delays of no more than 30 years. In the “generation” version, the immediate Program A benefited 30 year-olds and the delayed Program B benefited people who would be 30-years-old at the time that the benefits occurred. For example, if Program B was delayed by 30 years then it benefited people who were currently just being born and would be 30 years at the time Program B took effect. Generation questions used delays of up to 900 years. For delays of 30 years or more, Program B benefited people who were not yet born (that is, future generations).

Thus, the questionnaire presented to subjects contained the following versions and delays: age – 1 year, age – 2 years, age – 10 years, age – 30 years, generation – 1 year, generation – 2 years, generation – 10 years, generation – 30 years, generation – 60 years, generation – 300 years, generation – 900 years, for a total of 11 questions, each presented on a separate page. These questions will be abbreviated as A1, A2, A10, A30, G1, G2, G10, G30, G60, G300, and G600.

This questionnaire design afforded two types of comparisons. First, comparing the G1, G2, G10, and G30 questions to the G30, G60, G300, and G600 questions compares short delays (where the delayed benefits occur during the lifetime of the current generation) to long delays (where the delayed benefits occur during the lifetime of future generations). This contrast is the first type of comparison between intra- and inter-generational discount rates and operationalizes the distinction between intra- and inter-generational trade-offs as the difference between short and long delays.

The second comparison afforded by the questionnaire design was between the A1, A2, A10, and A30 questions and the G1, G2, G10, and G30 questions. This second comparison between intra- and inter-generational discount rates holds time delay constant and compares trade-offs where the delayed benefits occur to members of the current generation (who are then older) to trade-offs where the delayed benefits occur to members of a later birth cohort. This comparison operationalizes the distinction between intra- and inter-generational trade-offs as the difference between present and future birth cohorts.

In addition to the 11 discounting questions, participants also answered three brief questions at the beginning the questionnaire. They were asked whether “it is more important to save lives this year or many years from now?” (with response options of this year, many years from now, or both equally important), whether it is more

\footnote{Note that the G30 question is used twice, once to represent 30 years, and once to represent 1 generation.}
important to save the lives of younger or older people, and whether it is more important to save the lives of people in this generation or a future generation.

2.1.3. Procedure

Participants completed the questionnaire in group sessions. Four different versions of the questionnaire counterbalanced the order of the 11 pages and whether the benefits of the delayed Program B were presented in ascending (1 live–1000 lives) or descending order on each page.

Participants were instructed that “We are interested in what kind of public health programs are most worthwhile. The types of public health programs we will ask you to consider are those that save lives, for example by preventing accidents or disease, or cleaning up environmental toxins. The programs you will consider differ in some key respects: How many lives they save and when those lives are saved (e.g., now or later). In addition, sometimes the programs will differ in terms of the ages of the people whose lives are saved. All of the programs are the same in all other respects. You will consider many choices between programs. In each of the choices, both programs cost the same amount of money, and all of the expenditures for both programs occur right now, but there are only enough funds to pay for one of the programs.”

On each of the 11 pages of the questionnaire, participants were instructed that for each of the 16 pairwise choices, they should circle the letter of the program they would prefer to fund. In the age questions they were further told that all of the people who could benefit from the programs were people who turned 30 years old this year. In the generation questions they were told that these programs would benefit people who will turn 30 the year the program is implemented.

2.2. Results

Each participant provided 11 indifference points, one for each of the 11 questions. Fig. 1 shows the mean indifferent point for each of the 11 questions. As expected, the longer the delay for Program B, the more lives that program would have to save to be just as acceptable as program A. For a given delay, the age and generation versions of the question yielded similar indifference points.

The indifference points were converted to annual discount rates as follows:

\[ \text{rate} = \left( \frac{\text{indifference point}}{\text{immediate benefit}} \right)^{1/\text{delay}} - 1. \]

The geometric mean discount rates for each of the 11 questions are shown in Fig. 2. Annual discount rates were lower for longer delays. That is, the longer the delay, the smaller the percentage increase in value that was needed to offset each year of the delay. Such a delay effect has been demonstrated in a number of prior studies (Benzion et al., 1989; Chapman, 1996; Chapman & Elstein, 1995; Thaler, 1981), although prior studies did not use such long delays.
Fig. 1. Mean indifference points from Experiment 1 (number of people saved after $D$ delay equivalent to 100 people saved now) for age and generation questions plotted as a function of time delay.

Fig. 2. Geometric mean annual discount rates for Experiment 1.

The two comparisons between intra- and inter-generational discount rates can be made by examining Fig. 2. For the first comparison, discount rates for the generation questions with delays of 1, 2, 10, and 30 years (intra-generational delays) were compared to the generation questions with 30, 60, 300, and 600 year delays. (Note that the 30 year question is used twice in this analysis.) A $2 \times 4$ repeated measures ANOVA was conducted with unit of delay (years or generations) as one factor and number of delay units (1, 2, 10, or 30 years or generations) as the second factor. Two questionnaire counterbalancing factors were also included as between-subjects factors (order of the 11 questions across pages and order of the Program B benefits within a page – both
2-level factors). Because discount rates had a skewed distribution, the dependent measure in this ANOVA and those following was the natural logarithm of discount rate. The ANOVA revealed an effect of type of delay, $F(1, 53) = 14.76$, $MS_e = 0.09$, $P = 0.0003$, indicating that discount rates for inter-generational (long) delays were lower than those for intra-generational (short) delays. There was also a main effect of number of delay units or length of delay, $F(3, 159) = 6.93$, $MS_e = 0.04$, $P = 0.0002$. The linear contrast for this effect was also significant, $F(1, 53) = 12.11$, $MS_e = 0.10$, $P = 0.001$, indicating that within both types of delay, discount rate decreased as delay increased. There was also a type $\times$ delay interaction, $F(3, 159) = 4.06$, $MS_e = 0.03$, $P = 0.008$ indicating that discount rates decreased more rapidly from a 1 to a 30 year delay than they did from a 30 to a 900 year delay. This interaction could reasonably be attributed to a floor effect. The counterbalance factors interacted with several effects, but these results are not presented here.

For the second comparison between intra- and inter-generational discount rates, questions A1, A2, A10, and A30 were contrasted with questions G1, G2, G10, and G30. A 2 $\times$ 4 repeated measures ANOVA was conducted with type of question (age or generation) as one factor and length of delay (1, 2, 10, or 30 years) as the second factor. The ANOVA revealed a main effect of length of delay, $F(3, 159) = 5.39$, $MS_e = 0.12$, $P = 0.002$. The linear contrast of this effect was also significant, $F(1, 53) = 7.95$, $MS_e = 0.37$, $P = 0.007$, indicating that discount rates decreased with length of delay. The ANOVA showed no main effect of type of question type (age vs. generation), $F(1, 53) = 2.39$, $MS_e = 0.01$, $P = 0.13$. In addition, there was no interaction between type of question and length of delay, $F(3, 159) = 1.90$, $MS_e = 0.01$, $P = 0.13$.

Participants’ responses to the three short questions at the beginning of the questionnaire were examined. Twenty-three of the 57 participants answered “both equally important” to all three questions. This response pattern implied that these participants espoused zero discounting – that is, future outcomes should not be discounted because of age, generation, or time delay effects. One might therefore expect these 23 participants to express zero discounting on the 11 discounting questions. In fact, they used zero discount rates on an average of only 28% of the discounting questions. In comparison the other 34 participants used zero discount rates on 26% of the questions, which was not significantly different. The 23 “equally important” participants also did use discount rates that were lower than did the other participants (means 10.9% vs. 7.3%, n.s.). Thus, participants’ responses to the discounting questions were inconsistent with their own philosophy toward time preferences as expressed on the self-report questions. Similar results were found in Sections 3 and 4 but are not reported.

### 2.3. Discussion

The results of Experiment 1 indicate that the answer to the question as to whether inter-generational discount rates differ from intra-generational discounts depends on what comparison is made. When the distinction between intra- and inter-generational discount rates is operationalized as the difference between short and long
delays then the results show that inter-generational discount rates are indeed lower than intra-generational discount rates. When, however, the distinction between intra- and inter-generational discount rates is operationalized as the difference between preferences for delayed outcomes that occur to the present generation (later, when they are older) vs. delayed outcomes that occur to future birth cohorts, then the results show that inter-generational discount rates are indistinguishable from intra-generational rates. Put simply, the participants in this study based their responses solely on the length of the delay in years. They were uninfluenced by whether the consequence of the delay was that an older person was benefited or that a member of a future birth cohort was benefited.

The fact that discount rates were lower for long delays has at least three possible explanations. The first explanation is that decision makers treat events that happen in their own lifetime differently from those that happen further in the future. This strict distinction between own lifetime and future generations is not consistent with the fact that discount rates decreased gradually with delay (see Fig. 2). A second explanation is that the effect of delay seen here is the same phenomenon as the delay effect seen in previous studies that used shorter delays (Benzion et al., 1989; Chapman, 1996; Chapman & Elstein, 1995; Thaler, 1981). The theoretical explanation that has been advanced for this effect is that discounting follows a hyperbolic function such that the difference between, say, 1 and 2 years of delay has much more influence than the difference between 30 and 31 years of delay. Loewenstein and Prelec (1992) and Prelec and Loewenstein (1991) refer to this account as diminishing absolute sensitivity for time. If the present results are simply a replication of the previously known delay effect, they suggests that there is nothing special about inter-generational discounting. In other words, inter-generational discounting operates much like intra-generational discounting. In both cases, discount rates decrease with delay. Because inter-generational discounting (usually) involves longer delays, it will (usually) involve lower discount rates.

A final explanation is that the effect of time delay in the current experiment is an artifact of the methodology used and of common sense restrictions on responses. The discounting questions allowed participants to express an indifference between saving 100 lives now and saving from 1 to 1000 lives after a delay. If the delay was one year, then the maximum response of 1000 corresponded to a discount rate of 900%. If the delay was 900 years, then the maximum response of 1000 corresponded to a discount rate of 0.26%. Thus, the discounting problems with longer delays did not allow subjects to express high discount rates. This ceiling effect could account for the fact that longer delays yielded lower discount rates. In fact, whereas only 5% of the 1 year-delay responses were at ceiling, 61% of the 900 year-delay responses were at ceiling.

This methodological issue is more complex than it first appears. Although the maximum response ceiling could be raised for the longer-delay questions, subjects may still have common-sense ceilings that they self-impose, regardless of the responses allowed on the questionnaire. For example, the geometric mean discount rate for the 1 year-questions was 20%, meaning that participants valued saving 100 lives now the same as saving 120 lives in one year. If that same 20% discount rate were applied to a trade-off with a 900 year delay, it would involve valuing 100 lives
now the same as $10^{72}$ lives in 900 years. This response would likely be viewed as absurd because the number of people currently on the planet is less than $10^7$. Even a discount rate as low as 1% would require an indifference point in the 900 year question of about 800 million, a response that many participants may consider to be an unrealistic response. Thus, measuring subjective discount rates for very long delays is methodologically quite challenging. The methodology used in Experiment 1 is also used in Experiments 2 and 3 (Sections 3 and 4) with the caveat that the decrease in discount rate with time delay is potentially a methodological artifact and is therefore not the primary focus of the next two studies.

3. Experiment 2

As reviewed in Section 1, most past studies of inter-generational time preferences have measured time preferences for lives saved. In contrast, past studies of intra-generational time preferences have examined different outcomes, often money or health improvement. Intra-generational studies usually ask decision makers to evaluate outcomes that they themselves will experience weeks or years later. Lives saved do not form a continuum for individual choices made by a decision maker on his or her own behalf (since the decision maker has only one life to be saved). Consequently, intra-individual studies ask decision makers to consider continuous outcomes such as dollars or years in poor health and to evaluate what quantity of these outcomes occurring after a delay would be equal in utility to a given quantity immediately.

One reason why studies of inter-generational discounting of lives saved have sometimes yielded different results from intra-generation studies may be that discount rates for lives saved differ from discount rates for other outcomes. The purpose of Experiment 2 was to compare discount rates for lives saved to those for two other outcomes: health and financial benefits. Experiment 2 used only the generation question formats from Experiment 1 (not the age question formats) and examined discount rates for three domains and four time delays.

3.1. Method

3.1.1. Participants

The participants were 54 college students who participated as part of a class requirement.

3.1.2. Questionnaire

Participants completed a 12-page questionnaire. Each page elicited one discount rate through a series of 16 pair-wise choices, as in Section 2. The 12 pages resulted from crossing three outcome domains (lives saved, health improvements, and financial benefits) with four time delays (1, 10, 30, and 300 years). On each page participants were asked to consider public programs. For the lives saved outcomes, participants were told that the people affected by the program “are those who would ordinarily die at age 30, but will instead live to age 75”. For the health improvement
outcomes, they were told that the “people affected are 30 year-olds with painful arthritis who would normally have arthritis for the rest of their lives (until age 75) but now will be arthritis-free”. Finally, for the financial assistance outcomes they were told that the “people affected are 30 year-old single parents with low incomes who receive a one-time grant of $10,000 to be used for college tuition, training, purchase of a home or car, etc”. As in Experiment 1, each page presented a series of choices between Program A that benefited 100 people now or Program B that benefited a varying number of people after a delay. Across pages the delay varied among 1, 10, 30, and 300 years.

*Procedure.* The procedure was the same as that in Section 2. Six versions of the questionnaire varied the order of the 12 pages. Unlike Experiment 1, the order of the 16 pairwise choices presented on each page was not counterbalanced. Instead, they were always presented in ascending order.

### 3.2. Results and discussion

Fig. 3 presents the mean indifference points for each of the 12 questions. As expected, as the delay increased, a larger number of people had to be benefited in order to make the delayed program equivalent to an immediate program. Of primary interest, the curves for the three outcome domains were very similar, indicating that discounting did not vary with outcome domain. Indifference points were converted to annual discount rates, as in Section 2. Fig. 4 presents the geometric mean discount rate for each domain and each time delay. Discount rates decreased with time delay (although, as in Section 2, this result could be due to a ceiling effect for long delay questions). The three types of outcomes were very similar and differed noticeably only at the shortest delay.

![Graph](image)

Fig. 3. Mean indifference points from Experiment 2 (number of people benefited after $D$ delay equivalent to 100 people benefited now).
A repeated measures 3 × 4 ANOVA was conducted using the natural logarithm of discount rates as the dependent measure. The repeated measures were domain and time delay. Between-subjects counterbalance factors were also included. The ANOVA revealed a main effect of delay, $F(3, 138) = 10.45$, $MS_e = 2.14$, $P = 0.0001$ (linear contrast $F(1, 46) = 18.58$, $MS_e = 0.63$, $P = 0.0001$), but no effect of outcome domain $F(2, 92) = 1.15$, $MS_e = 0.04$, $P = 0.32$, and no interaction between the two $F(6, 276) = 1.36$, $MS_e = 0.04$, $P = 0.23$. Thus, outcome domain did not influence average time preferences.  

Previous research (Chapman, 1996; Chapman & Elstein, 1995; Chapman, Nelson, & Hier, 1999) has found that discount rates from one domain (e.g., health) are not correlated with those from other domains (e.g., money). That is, even if the same average discount rate is used in two domains, domain differences can nonetheless arise in the form of low inter-domain correlations (relative to intra-domain correlations). The results from Experiment 2 were analyzed to see if they demonstrated this domain independence. A principle components analysis was conducted on the 12 discount rates. Three factors explained 78% of variance in discount rates (number of factors selected by the Mineigen criterion). Table 2 displays the factor loadings after a varimax rotation. If the current results showed domain independence, we would expect the three factors to correspond to the lives, health, and money domains. Instead, the factor pattern shows that questions fell into factors according to both the outcome domain and the time delay. Factor 2, for example, consists of 1 year

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3 There was also a significant interaction between time delay and two counterbalancing factors and also between time delay, domain, and one counterbalancing factor. The latter interaction indicates that for the 1 year time delay, money discount rates (20%) were lower than those for health (28%) and lives saved (49%) in the condition in which 1 year delays were evaluated after longer delays. In the condition where 1 year delays were evaluated before longer delays, money discount rates (39%) were higher than those for health (22%) and lives saved (30%).
Table 2
Principal components analysis for Experiment 2

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Money 300</td>
<td>0.88</td>
<td>0.15</td>
<td>-0.04</td>
</tr>
<tr>
<td>Money 30</td>
<td>0.83</td>
<td>-0.30</td>
<td>-0.31</td>
</tr>
<tr>
<td>Health 300</td>
<td>0.83</td>
<td>0.19</td>
<td>-0.27</td>
</tr>
<tr>
<td>Lives 300</td>
<td>0.74</td>
<td>0.31</td>
<td>0.26</td>
</tr>
<tr>
<td>Money 10</td>
<td>0.70</td>
<td>-0.20</td>
<td>0.37</td>
</tr>
<tr>
<td>Health 30</td>
<td>0.69</td>
<td>0.50</td>
<td>0.18</td>
</tr>
<tr>
<td>Health 1</td>
<td>-0.04</td>
<td>0.92</td>
<td>0.14</td>
</tr>
<tr>
<td>Lives 1</td>
<td>-0.07</td>
<td>0.87</td>
<td>0.33</td>
</tr>
<tr>
<td>Money 1</td>
<td>0.20</td>
<td>0.73</td>
<td>-0.19</td>
</tr>
<tr>
<td>Lives 10</td>
<td>0.01</td>
<td>0.08</td>
<td>0.92</td>
</tr>
<tr>
<td>Lives 30</td>
<td>0.40</td>
<td>0.31</td>
<td>0.80</td>
</tr>
</tbody>
</table>

time delay questions. Thus, Experiment 2 found less influence by outcome domain than has been seen in previous studies.

4. Experiment 3

Inter-generational time preferences involve decisions made on behalf of other people. The decision maker evaluates an outcome that will occur to one or more people in a future generation. Thus, the beneficiary of the decision is not only someone other than the decision maker, but is also someone unfamiliar and unacquainted with the decision maker. Consequently, delayed outcomes might be discounted not only because of time delay but also because of psychological distance between the decision maker and the beneficiary. That is, self interest does not provide a rationale for valuing delayed outcomes (as it does when the delayed outcomes occur to the decision makers); instead an altruistic value for unknown others is needed. In this way, inter-generational decisions are similar to decisions made on behalf of people geographically distant (Parfit, 1984).

If members of future generations are analogous to current residents in geographically distant locations, then outcomes will be discounted because of either time or distance. This argument leads to the prediction that a present, distant outcome has already been discounted because of distance and will not be much further discounted as it becomes delayed in time, since most discounting occurs during the first few units of time (or distance). In contrast, a present near outcome is not discounted at all and will therefore be noticeably discounted as it becomes delayed in time. Together, these predictions imply that near outcomes will be temporally discounted more steeply (at a higher discount rate) than distant outcomes.
The purpose of Experiment 3 was to test whether psychological and geographical distance between the decision makers and beneficiary influenced inter-generational discount rates. The study participants evaluated outcomes that occurred to people psychologically and geographically close to them (New Jersey residents) or to people psychologically and geographically distant (residents of Thailand). The prediction outlined earlier is that a higher discount rate will be applied to New Jersey residents than to Thai residents.

4.1. Method

4.1.1. Participants
The participants were 80 undergraduate students at Rutgers University who participated as part of a class requirement. Seventy-three percent of them had lived in New Jersey for at least three-quarters of their lives. None had ever lived in Thailand and none was of Thai descent.

4.1.2. Questionnaire
Participants completed an 8 page questionnaire in which they evaluated life-saving programs that benefited young adults living either in New Jersey or Thailand after delays of 1, 10, 30, and 300 years. Four versions of the questionnaire counterbalanced the order of country (New Jersey or Thailand first) and the order of the time delays (ascending or descending).

4.1.3. Procedure
The procedure was the same as in Section 3.

4.2. Results and discussion

Fig. 5 presents the mean indifference points for each of the 8 questions. As expected, as the delay increased, a larger number of people had to be benefited in order to make the delayed program equivalent to an immediate program. Of primary interest, the curves for the Thai and New Jersey residents were completely overlapping, indicating that discounting did not vary with type of beneficiary. Indifference points were converted to annual discount rates and are shown in Fig. 6. As in the previous experiments, discount rates decreased with time delay (and as before, this result could be due to a ceiling effect).

A repeated measures 2 × 4 ANOVA was conducted using the natural logarithm of discount rates as the dependent measure. The repeated measures were beneficiary (New Jersey or Thailand residents) and time delay. Between-subjects counterbalance factors were also included. The ANOVA revealed a main effect of delay, $F(3,213) = 19.88$, $MS_e = 0.13$, $P = 0.0001$ (linear contrast $F(1,71) = 31.82$, $MS_e = 0.15$, $P = 0.0001$), but no effect of beneficiary, $F(1,71) = 0.05$, $MS_e = 0.01$,
Fig. 5. Mean indifference points from Experiment 3 (number of people saved after D delay equivalent to 100 people saved now).

Fig. 6. Geometric mean annual discount rates from Experiment 3.

\( P = 0.82 \), and no interaction between the two \( F(3, 213) = 0.35 \), \( \text{MS}_e = 0.01 \), \( P = 0.79 \). Thus, beneficiary did not influence discount rates.\(^4\)

As in Section 3, discount rates were factor analyzed to see if they demonstrated domain independence. A principle components analysis was conducted on the 8

\[^4\text{There was also a significant interaction between time delay and two counterbalancing factors and also between time delay, domain, and one counterbalancing factor. The latter interaction indicates that for the 1 year time delay, New Jersey rates were higher than Thai rates for one of four counterbalance conditions, Thai rates were higher for a second condition, and the two were tied for the other two conditions.}\]
discount rates. Two factors explain 80% of variance in discount rates (number of factors selected by the Mineigen criterion). Table 3 displays the factor loadings after a varimax rotation. If discount rates for New Jersey beneficiaries were uncorrelated with those for Thai beneficiaries, then the two should load on separate factors. Instead, the factor pattern shows that questions fell into factors according to time delay only. The 300 year questions loaded on factor 1, the 1 year questions loaded on factor 2, and the 10- and 30-year questions loaded on both factors, although more heavily on factor 1. Thus, participants used different discount rates according to the time delay.

5. General discussion

5.1. Two views of inter-generational discounting

Two descriptive theoretical perspectives on inter-generational discounting can be contrasted. The first perspective is that decision makers approach inter-generational trade-offs as time problems and consequently treat them like any other time preference problem. According to this perspective, inter-generational discounting should look very similar to time preferences examined in studies of individual inter-temporal choice. This view is the descriptive analogue to the normative position (e.g., Gold, Siegel, Russell & Weinstein, 1996; Lipscomb, Weinstein & Torrance, 1996) that the same discount rate should be applied to both intra- and inter-generational outcomes – that is, that both types of trade-offs should be approached similarly. This perspective posits that previous findings on the psychology of time preferences will apply even to inter-generational discounting. For example, annual discount rates should be lower for long delays than for short delays both in intra- and inter-generational discounting.

A second theoretical perspective is that decision makers do not approach inter-generational trade-offs as inter-temporal choices; that is, time delay is not an important component of such trade-offs. According to this descriptive view, decision makers approach inter-generational trade-offs as decisions involving issues such as fairness, efficient and equitable distribution of resources, and altruism. Thus,
inter-generational decisions are seen more as decisions about foreign aid rather than decisions about savings. This view is the descriptive analogue to Schelling (1996) normative position that it is inconsistent to make sacrifices to help future generations if one is unwilling to make sacrifices to help other people in the present generation, since future generations are other people as well. If decision makers adopt this perspective, then inter-generational time preferences should look very different from the personal time preferences examined in previous studies.

The current results support the first perspective. Inter-generational discount rates were very similar to intra-generational rates, and there was little effect of factors often associated with inter-generational trade-offs, such as psychological distance of the beneficiary or life-saving outcomes (as opposed to other types). Inter-temporal choices with very long, inter-generational delays did elicit lower annual discount rates, but this pattern is likely due to a methodological ceiling effect or may reflect an extension of the delay effect seen in previous intra-generational discounting studies. It appears not to reflect a qualitative difference between inter- and intra-generational time preferences. In short, it appears that participants in the current studies based their choices on the number of people benefited and the delay to the benefit, and not on other factors.

5.2. Influence of beliefs and expectations

The strict attention to the numerical aspects of the choices (number of beneficiaries and number of years of time delay) observed in the current studies may have been encouraged by the abstract and hypothetical nature of the decision scenarios presented. Participants might have responded differently to enriched scenarios that described real inter-generational trade-offs, such as decisions about siting nuclear waste sites, vaccination, or pension funds. Responses to more realistic scenarios, however, are likely to incorporate more than just time preferences. Participants will likely have theories about how the problem or solution methods will change over time that may guide their responses more than will time considerations. For instance, a decision maker might opt for an immediate public health program over a delayed, more effective program not because she has a high discount rate but rather because she has specific beliefs about the future. She might believe, for example, that medical advances would make the future health program unnecessary. Alternatively, the decision maker might discount the future because of uncertainty rather than time preference. For example, she might think it possible that, at the time of the future program, there would be no life left on earth (due, perhaps to nuclear war). The future program would thus have no value, supporting the choice of the immediate program.

All studies of time preferences, whether intra- or inter-generational, face the challenge of measuring pure time preferences (Gafni, 1995) that are uninfluenced by beliefs, expectations, or estimates of uncertainty. The influence of such factors might be of particular concern in studies of inter-generational time preferences where extremely long delays may result in greater uncertainty about future events or more elaborate beliefs about what changes might take place during the delay. Consequently, simplified, abstract scenarios were selected for the current studies with the intention of capturing time preferences uninfluenced by such beliefs or expectations.
Because real-world inter-generational trade-offs involve considerations other than time preferences, one might wonder about the importance of assessing pure time preferences. Why not allow scenario responses to reflect all of the factors that could and should influence real inter-generational decisions? Measurement of pure time preferences is important for two reasons. First, time preferences represent a general decision process that should apply to all decisions that involve delayed outcomes. Whereas specific beliefs about the future apply only to relevant scenarios (e.g., beliefs about medical advances apply only to decisions about medical interventions and not, say, to decisions about global warming), time preferences should apply much more generally. A second reason to measure pure time preferences is to ensure that each component of a decision has the appropriate influence. A decision analysis specifies the probabilities, utilities, and delays of each outcome. If the time preference measure incorporated not only time discounting but also, say, beliefs about uncertainties, then uncertainty information would be double-counted (once in the probabilities and again in the time preference measure).

5.3. Methodological issues

The current studies illustrate the methodological difficulties of measuring inter-generational discount rates. In decisions that involve very long delays, even a small discount rate will result in a very large ratio between the magnitudes of the immediate and delayed outcomes. For example, as discussed in Section 2, for an annual discount rate of 1%, saving 100 lives now is equivalent to saving 800 million lives 900 years from now. A response scale that does not extend to 800 million (such as that in the current studies) is not able to measure a discount rate this high for a delay of such length. Even if the response scale permitted such extreme responses, participants might reject them as implausible.

How might discount rates for long delays be measured? Scale limitations can be partially addressed by using more moderate delays, such that magnitudes stay within a plausible range while still allowing for large discount rates. (For example, with a shorter delay of 100 years, a higher annual discount rate of 10% equates 100 lives now with 1.4 million lives later.) Scale limitations can also be addressed by using a scale without a natural limit. For example, instead of asking participants how many lives a delayed program should save to be equivalent to a program saving 100 lives now, a study could instead ask participants how delayed a program saving 10,000 lives would need to be to make it equivalent to a current program saving 100 lives. (For example, a response of 48 years would indicate a 10% discount rate.) The response scale then becomes time delay, a dimension that does not have a natural upper limit in the way that number of lives saved does.

An alternative approach is to measure time preferences using a procedure that does not compute discount rates. Svenson and Karlsson (1989) measured preferences for outcomes that occurred with delays of up to 2 million years by asking participants to rate the events on a 10-point scale, where the immediate event had been standardized to a rating of 10. Because this procedure does not allow for the computation of discount rates (unless one interprets the 10-point scale as a utility scale),
it cannot be used to compare discount rates for short and long delays. It does, however, allow for an examination of how preferences are affected by delay. Svenson and Karlsson found that 30% of their participants expressed zero discounting by giving a rating of 10 for all delays.

5.4. Conclusion

Decision makers in the current study approached inter-generational trade-offs in a manner quite similar to intra-generational trade-offs. Thus, it appears that one descriptive theory of time preferences can account for both types of decisions. Future research is needed, however, to address methodological issues in measuring inter-generational discount rates and to separate time preferences from other factors influencing inter-generational decisions.

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