

## Value for the Future and Preventive Health Behavior

Gretchen B. Chapman, Noel T. Brewer,  
Elliot J. Coups, Susan Brownlee, and  
Howard Leventhal  
Rutgers, The State University of New Jersey

Elaine A. Leventhal  
Robert Wood Johnson Medical School, University of Medicine  
and Dentistry of New Jersey

Many everyday decisions require trade-offs between immediate and delayed benefits. Although much research has assessed discounting of delayed outcomes by using hypothetical scenarios, little research has examined whether these discounting measures correspond to real-world behavior. Three studies examined the relationship between scenario measures of time preference and preventive health behaviors that require an upfront cost to achieve a long-term benefit. Responses to time preference scenarios showed weak or no relationship to influenza vaccination, adherence to a medication regimen to control high blood pressure, and adherence to cholesterol-lowering medication. The finding that scenario measures of time preference have surprisingly little relationship to actual behaviors exemplifying intertemporal trade-offs places limits on the applications of time preference research to the promotion of preventive health behavior.

Recent research on decision making has explored *intertemporal choice*, that is, making decisions that involve a trade-off between something now and something later (e.g., Chapman, 1998; Loewenstein & Elster, 1992; Loewenstein & Thaler, 1989). Such decisions are thought to reflect the decision maker's time preference or the extent to which delayed outcomes are discounted relative to immediate ones. Time preferences are inherently interesting because of the abundance of everyday behaviors that seem to exemplify intertemporal choice. Examples include investing for retirement, starting a low-calorie diet, studying for an exam, and organizing one's office. All of these can be viewed as examples of accepting a short-term cost in exchange for a long-term gain. Whether one engages in these behaviors should be determined, in part, by time preference.

Time preferences have been researched in diverse areas of psychology and related disciplines, including decision-making research (Chapman, 1998; Loewenstein & Elster, 1992), animal learning (Grace, 1999; Mazur, 2001), behavioral psychology (Ains-

lie, 1975; Kirby & Herrnstein, 1995; Rachlin, Raineri, & Cross, 1991), and economics (Bohm, 1994; Cropper, Aydede, & Portney, 1992). An understanding of the psychological mechanisms underlying intertemporal choice is of broad interest in psychology.

Research on intertemporal choice has examined time preferences using two different methodologies. Most studies of time preferences (e.g., Ben Zion, Rapoport, & Yagil, 1989; Chapman, 1996; Thaler, 1981) have presented participants with hypothetical choices between an immediate outcome and a delayed outcome. The participant specifies how large the delayed outcome would have to be to make it just as attractive as the immediate outcome, thus indicating the participant's time preference. A few studies (e.g., Dreyfus & Viscusi, 1995; Hausman, 1979; Moore & Viscusi, 1990) have relied on real-world behavior as the indicator of time preferences. These studies analyze wage or consumer purchase data to identify the time preferences implicit in market behavior. For example, Hausman (1979) estimated the implicit time preferences of consumers based on the cost and energy efficiency of the household appliances they purchased, and Moore and Viscusi (1990) analyzed labor market data to impute workers' time preferences based on the wages paid for jobs with different mortality risks. Few studies have empirically examined whether time preferences measured with hypothetical choices correspond with time preferences implicit in real-world behavior.

The purpose of the present studies was to examine the correspondence between time preferences measured with hypothetical scenarios and real-world behaviors thought to reflect time preferences. The particular behaviors examined in the present studies are three preventive health behaviors: getting an influenza vaccination ("flu shot"), taking medication to control hypertension, and taking medication to control high cholesterol. The benefits derived from these behaviors are delayed because preventive health behaviors serve to prevent a future adverse health outcome. In contrast, their costs and inconveniences are often immediate.

Time preferences measured with hypothetical scenarios can be quantified as a discount rate or the percentage increase in magni-

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Gretchen B. Chapman, Noel T. Brewer, and Elliot J. Coups, Department of Psychology, Rutgers, The State University of New Jersey; Susan Brownlee, Institute for Health, Health Care Policy, and Aging Research, Rutgers, The State University of New Jersey; Howard Leventhal, Department of Psychology and Institute for Health, Health Care Policy, and Aging Research, Rutgers, The State University of New Jersey; Elaine A. Leventhal, Department of Medicine, Robert Wood Johnson Medical School, University of Medicine and Dentistry of New Jersey.

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Correspondence concerning this article should be addressed to Gretchen B. Chapman, Rutgers, The State University of New Jersey, Department of Psychology, Busch Campus, 152 Frelinghuysen Road, Piscataway, New Jersey 08854-8020. Electronic mail may be sent to gbc@rci.rutgers.edu.

tude needed to offset each year of delay. For example, a 20% annual discount rate entails that \$100 received immediately is just as attractive as \$120 to be received in 1 year. A positive discount rate indicates that present gains are preferred to future gains (and that future losses are preferred to present losses). A negative discount rate indicates that future gains are preferred to present ones (and that present losses are preferred to future ones). In this article, the terms *time preference* and *discount rate* are used interchangeably.

Most past studies of time preferences measured with hypothetical choices have examined decisions about money. Some of these studies of monetary time preferences have used a scenario such as winning a lottery (e.g., Chapman, 1996; Chapman & Elstein, 1995; Chapman, Nelson, & Hier, 1999; Chesson & Viscusi, 2000; Thaler, 1981), receiving a payment (e.g., Benzion et al., 1989; Bohm, 1994), or paying a fine (e.g., Benzion et al., 1989; Chapman & Coups, 1999; Thaler, 1981). Other studies have simply presented choices between immediate and delayed amounts of money without any associated scenario (e.g., Bickel, Odum, & Madden, 1999; Cairns, 1992; Fuchs, 1982; Kirby & Herrnstein, 1995; Kirby, Petry, & Bickel, 1999; Madden, Petry, Badger, & Bickel, 1997; Simpson & Vuchinich, 2000; Vuchinich & Simpson, 1998). Because the current studies measured health behavior, they also measured time preferences with hypothetical choices about health. Like the measures in the current studies, past studies of health-time preferences have almost always used a scenario, often involving a description of a health state (e.g., Cairns, 1992; Chapman, 1996; Chapman & Coups, 1999; Chapman & Elstein, 1995; Chapman et al., 1999; Redelmeier & Heller, 1993; van der Pol & Cairns, 2001). Studies of hypothetical time preferences for both money and health, including those in the current studies, present a comparison between an immediate or near future outcome and a more delayed outcome. Participants are asked either to make a choice (e.g., Bickel et al., 1999; Bohm, 1994; Chapman et al., 1999; Cropper et al., 1992; Fuchs, 1982; Kirby & Herrnstein, 1995; Kirby et al., 1999; Madden et al., 1997; Simpson & Vuchinich, 2000; van der Pol & Cairns, 2001; Vuchinich & Simpson, 1998) or to specify the magnitude of one of the two options to make the two equivalent in preference (e.g., Benzion et al., 1989; Chapman, 1996; Chapman & Coups, 1999; Chapman & Elstein, 1995; Loewenstein, 1988; Thaler, 1981).

## PREVIOUS RESEARCH

Several previous studies have examined the relationship between temporal discount rates as measured with hypothetical choices and real-world behaviors thought to reflect time preferences. In one such study, Fuchs (1982) compared monetary discount rates to self-reports of several health behaviors. He asked 508 community members a series of monetary time preference questions such as "Would you choose \$1,500 now or \$4,000 in five years?" The monetary amounts and delays varied across questions so as to identify each respondent's discount rate. Fuchs also asked about several health behaviors: smoking, exercise, seat belt use, dental exams, and being overweight. Discount rates had a small relationship to smoking. In addition, exercise was related to discount rates for men, but in the opposite direction to the expected direction (men who placed more value on future outcomes exercised less). Discount rate was not significantly corre-

lated with any of the other health behaviors, although these relationships were in the expected direction. A measure of health status did show a small correlation with time preference, suggesting that those with low discount rates may engage in more health-improving behaviors. Thus, time preferences were related to some, but not all, measures of health behavior, and the observed correlations were quite small. Fuchs did find that time preference was related to other respondent characteristics, such as age and education, indicating that it is possible to detect correlates of time preference.

Chapman and Coups (1999) examined the relationship between responses to hypothetical intertemporal trade-offs and acceptance of an influenza vaccine. They found a small but significant relationship between vaccine acceptance and one of their three hypothetical choice measures of time preferences. Their results suggested some correspondence between hypothetical choice-time preference measures and preventive health behaviors (such that people who place a higher value for future outcomes are more likely to engage in such behaviors), but that the relationship is small and may be found with some measures but not with others.

Some of the best evidence for the relationship between time preference measures and health behavior comes from several recent studies that examined the relationship between temporal discount rates and addictive behaviors (Bickel et al., 1999; Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998). Addictive behavior can be understood as an instance of intertemporal choice in that the user makes a choice of whether to engage in an immediately pleasurable activity (using the substance) that carries a long-term cost (sustained addiction with negative consequences for health, job, etc.) (Herrnstein & Prelec, 1992). In several studies addicts and matched controls were presented with monetary choices between immediate and delayed sums of money. Participants' choices indicated their indifference points for each of several temporal delays, and discount functions were fit to the indifference points. The resulting discount rates were higher for heroin addicts than for matched non-drug-using controls (Kirby et al., 1999; Madden et al., 1997), higher for current cigarette smokers than for ex-smokers and never-smokers (Bickel et al., 1999), and higher for heavy social drinkers and problem drinkers than for light social drinkers (Vuchinich & Simpson, 1998). Chesson and Viscusi (2000), in contrast, used a somewhat different hypothetical measure of time preference and found that discount rates were higher for nonsmokers than for smokers, contrary to expectation. Addictive behaviors may represent a class of health behaviors that are especially likely to reflect time preferences, although the mixed findings suggest that different types of time preference measures might show different relationships to behavior.

In summary, a handful of previous studies have examined the relationship between real-world behavior and hypothetical measures of time preference. Notably, all of these studies measured health behaviors. Fuchs (1982) and Chapman and Coups (1999) found only small relationships between discount rates and health behavior, and these relationships were not detected for all measures of time preference or all behaviors. Chesson and Viscusi (2000) found results in the contrapredicted direction. In contrast, Bickel and colleagues (Bickel et al., 1999; Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998) found reliable and consistent associations between time preferences and addictive behaviors. The small number of studies and their somewhat vari-

able results leave us without a clear answer to the question of whether time preferences as measured with hypothetical scenarios correspond to preventive health behaviors thought to mirror time preferences.

The purpose of the present studies was to examine the relationship between the scenario time preference measures used most extensively in past research and preventive health behaviors. Three such health behaviors were examined to assess the consistency of any relationship. We examined whether, in each case, people who had lower temporal discount rates (that is, those who place higher value on future outcomes) would be more likely to engage in the preventive health behavior. Because time preference is just one of many factors likely to affect preventive health behaviors, and because hypothetical scenario measures are likely to reflect other factors in addition to time preference, we anticipated that any relationship between hypothetical measures of time preference and behavior might be modest.

### Study 1: Influenza Vaccination

In Study 1, we examined the decisions of working adults to accept or decline a free influenza vaccination offered at their workplace. This study served as a replication and extension of Chapman and Coups (1999), with an improvement in methods described later. Acceptance of a flu shot represents an intertemporal choice because, like most preventive health behaviors, it involves an up-front cost and a delayed benefit. Cost and inconvenience of the vaccine, such as travel to the employee health center, and pain of the injection, occur right away. Also, possible side effects from the injection, such as a sore arm, occur soon after. In contrast, the benefits are delayed. The vaccine is administered in October and November but takes 2 weeks to become active, and the cases of influenza that the shot is intended to prevent usually occur several months later. Consequently, one would expect that people who place a high value on future outcomes would be more likely to accept the vaccine.

The primary purpose of Study 1 was to examine the relationship between flu shot acceptance and hypothetical scenario-based measures of time preferences. Participants responded to two scenarios (one health and one monetary) that presented choices between immediate and delayed outcomes. A secondary purpose of Study 1 was to examine whether flu shot acceptance would correlate more strongly with the health scenario measure of time preference than with the monetary scenario measure. A subset of Study 1 participants also reported on contributions to their retirement fund, and we examined whether retirement fund contributions were correlated more strongly with the monetary scenario-time preference measure than with the health scenario measure. Such a result would be consistent with past findings of domain independence (Cairns, 1992; Chapman, 1996; Chapman & Elstein, 1995; Chapman et al., 1999), the fact that health and money discount rates are not well correlated with one another, although discount rates are quite reliable within domains.

A final purpose of Study 1 was to examine the reliability of both the health behavior measure and the scenario measures of time preferences. A lack of correspondence between the two types of measures could result from a lack of reliability in one or both measures. Consequently, for a subset of participants, both types of measures were reassessed 1 year following the initial assessment.

## Method

### Participants

The participants in this study were faculty and staff of Rutgers University and the University of Medicine and Dentistry of New Jersey (UMDNJ), Piscataway campus. Campus health services at both universities offer free flu shots each Fall at four campus health centers. In late November (after flu shot dispensing was complete), questionnaires were distributed to the mail boxes of 2,244 campus employees who were asked to return their completed questionnaires through campus mail. Participants were entered into a lottery to receive a monetary prize.

Questionnaires were distributed in two waves: 1,649 distributed in Wave 1 in Fall 1998 and 595 in Wave 2 in Fall 1999. Participants in the Wave 2 (Fall 1999) were also mailed questionnaires in Spring 2000 and Fall 2000. Those Wave 2 respondents who completed these follow-up questionnaires provided information on retirement investment behavior (Spring 2000) as well as test-retest reliability of time preference measures and consistency across years of vaccine acceptance (Fall 2000).

Within 2 months of the main questionnaire distribution, 871 completed questionnaires had been returned, for a response rate of 39%. We removed from the analyses 149 participants (17%) who reported that they were not aware that free flu shots had been offered. Data from a further 43 participants (5%) were excluded as they were missing responses to both of the time preference questions. All analyses were therefore conducted on the remaining sample of 679 participants, 280 (41%) of whom reported receiving a flu shot. Sixty-four percent of respondents were female, 79% were White, and the average age was 43 (range = 21–70). Of the 229 Wave 2 participants, 206 (90%) completed the Spring 2000 questionnaire, and 168 (80%) completed the Fall 2000 questionnaire.

### Procedure

Participants completed a questionnaire that included two sets of questions used for the present analysis.

*Flu shot acceptance.* The first set of questions concerned participants' acceptance of the flu shot. One question asked whether the participant was aware that free flu shots had been offered on campus. As explained previously, those who were unaware were removed from analysis on the grounds that employees could not make a decision to accept or decline a vaccination if they were unaware that the option was available. Repeating the analyses without excluding these participants did not change the relationship between flu shot acceptance and time preference measures. The question that comprised our dependent measure asked participants whether they had received a flu shot during the prior Fall months. Participants were also asked when they expected to get the flu, if they were to get it. This item was included because time preferences should be particularly predictive of flu shot acceptance among those people who view the flu as a delayed event (and thus view preventing the flu as a delayed benefit).

To provide a comparison behavior, the Wave 2 participants were asked whether they made voluntary contributions to their retirement account (in addition to the mandatory contributions). Forty-two percent of respondents indicated that they did make voluntary contributions, and these respondents contributed an average of 9% of their income. Forty-five percent of respondents did not make contributions, 6% did not currently contribute but had in the past, and 7% did not know whether they contributed or reported that voluntary contribution was not an option for them.

*Scenario measures of time preference.* The second set of questions consisted of two scenarios designed to measure time preferences. These scenarios concerned decisions in both a monetary and a health domain.

*Monetary time preference.* Participants were presented with a monetary scenario similar to those used in several previous studies (Benzion et al., 1989; Chapman & Coups, 1999; Thaler, 1981):

Imagine that your car just got towed. When you arrive at the impound to retrieve your car, you are given the choice of paying a \$70 fine now

or an alternate fine 4 months from now. This fine may vary from \$10 to \$120. Either way you will get your car back right away.

Participants made a series of choices between an immediate \$70 fine and an alternate fine delayed by 4 months. The amount of the delayed fine varied from \$10 to \$120 across the choices.<sup>1</sup> The participant's indifference point was defined as the largest delayed fine that was preferred over the immediate \$70 fine. For example, if a participant preferred paying \$80 later to paying \$70 now, but also preferred paying \$70 now to paying \$90 later, the indifference point would be \$80. Because paying a fine is a negative event or loss, an indifference point of less than \$70 (the amount of the immediate fine) represents a negative discount rate (placing more weight on future than on immediate outcomes), and an indifference point of more than \$70 represents a positive discount rate (more weight on immediate outcomes).

The indifference point was transformed to a  $-7$  to  $+5$  scale to indicate the amount of money (in tens of dollars) that had to be added to or subtracted from \$70 to make the delayed option equal in attractiveness to the immediate option. If, for example, a delayed \$100 fine was the largest fine preferable to an immediate \$70 fine, a score of  $+3$  was assigned to indicate that an additional \$30 would be tolerated because of the 4-month delay. With this scoring method, positive scores indicated positive time preferences and negative scores represented negative time preferences. A score of 0 indicated neutral time preference (e.g., a \$70 delayed fine was equivalent to a \$70 immediate fine). The scale from  $-7$  to  $+5$  reflected the fact that delayed monetary outcomes ranged in value from \$10 to \$120. A score of  $+5$  indicated that all delayed fines (up to and including the largest one of \$120) were preferred to the immediate fine. A score of  $-7$  indicated that no delayed fine (not even the smallest one of \$10) was preferred to the immediate fine.

**Health time preference.** After completing the monetary time preference items, participants read a health scenario similar to those used in previous studies (Cairns, 1992; Chapman & Coups, 1999; Redelmeier & Heller, 1993; van der Pol & Cairns, 2001):

Imagine that you get the flu this winter. You feel so weak and achy that you can't get out of bed. You have a high fever, a sore throat, and a persistent, painful cough. You sneeze and your nose is runny and stuffy. One way you might experience the flu is having a 7 day flu that starts today. Alternatively, your flu could start 4 months from now and last anywhere from 1 to 12 days.

Participants answered a series of choices between an immediate 7-day flu and a flu delayed by 4 months. The duration of the delayed flu varied from 1 to 12 days across the choices. As with the analogous monetary question, the participant's indifference point was transformed to a  $-7$  to  $+5$  scale that indicated the number of days that had to be added to or subtracted from 7 to make the delayed option equal in attractiveness to the immediate option.

It is important to note that the time preference measures allowed for the detection of negative discount rates. This feature represents an improvement over the study conducted by Chapman and Coups (1999), which used a time preference measure that only allowed for the detection of zero and positive discount rates. About 85% of the participants in that study expressed a zero discount rate, leading to a skewed distribution. It is possible that many of those participants had negative discount rates that could not be expressed with the response measure used. The measures used in the current study were designed to provide a more normal distribution of discount rates that would be more likely to show a relationship to flu shot acceptance.

The health scenario was designed to be similar in content to the vaccination decision while also posing a trade-off between two outcomes that were identical in all respects other than delay and magnitude (operationalized as duration of the flu illness). Because a flu illness is a negative event, the monetary scenario was parallel in design by also describing a negative event.

**Test-retest reliability.** One year following completion of the main questionnaire, the Wave 2 subset of participants completed another questionnaire containing the same flu shot questions and time-preference scenario items as in the original questionnaire.<sup>2</sup>

## Results

**Time preference responses.** Indifference points from the time preference scenarios were distributed across the entire range of the scale. The average time preferences were negative, with means of  $-1.05$  for the monetary scenario ( $SD = 1.87$ ), and  $-0.61$  ( $SD = 2.26$ ) for the health scenario. The correlation between monetary and health time preference was small, but significant ( $r = .24$ ,  $N = 679$ ,  $p < .0001$ ). Note that because of missing data, monetary time preference could not be calculated for 8 participants, and health time preference could not be calculated for 14 participants. To ensure that all analyses were conducted on the same sample, these missing values were replaced with the mean.

**Relationship between time preference and vaccine acceptance.** Of primary interest was the question of whether responses to the time preference scenario questions predicted which participants had received a flu shot. To address this question, we examined the correlations between the two time preference measures and acceptance of the flu shot. We predicted that participants with high positive time preferences would be less likely to accept the flu shot than those with lower or negative time preferences. The correlations are shown in Table 1 and are coded so that positive correlations indicate relationships in the predicted direction. Given the Sample 1 size of 679, we had the power to detect a correlation of 0.11 or larger (with an alpha of 0.05 and a beta of 0.20). As shown in Table 1, monetary time preference showed a small correlation ( $r = .12$ ,  $p = .002$ ) with flu shot acceptance. Those who accepted the flu shot had a monetary time preference score of  $-1.31$  compared with  $-0.86$  for those who declined the shot,  $t(677) = 3.10$ ,  $p = .002$ . In other words, there was a small tendency for people who accepted the flu shot to have more negative time preferences. Health time preferences were not correlated with flu shot acceptance ( $r = .06$ ,  $p = .14$ ). Both time preference measures combined (health and money scenarios) explained a total of 1.5% of the variance in flu shot acceptance (multiple  $r$  of .12), which was significant,  $F(2, 676) = 5.08$ ,  $MSE = 0.24$ ,  $p = .007$ . This combined effect was due entirely to the monetary measure.

<sup>1</sup> For Wave 1 participants, there was also a choice with a delayed fine of \$140. To make the analyses compatible for all participants, this choice was collapsed with the delayed fine choice of \$120. Also note that Wave 1 participants were provided with 10 choices (including the \$140 choice), whereas the Wave 2 participants were provided with 6 choices. The above illness was also true for the flu time preference question (with a maximum duration of 14 days for the Wave 1 participants); thus, the same analytic approach was used.

<sup>2</sup> This questionnaire was mailed in November 2000. Production of the flu vaccine was delayed that Fall, and as a result flu shots were not available at the campus health centers until mid-December—after most participants had completed the questionnaire. Consequently, participants who had not yet received a vaccine at the time of questionnaire completion were mailed a one-page addendum in January 2001 asking whether they had received a flu shot.

Table 1  
Pearson Correlations Between Time Preference Measures and Real-World Behavior in Study 1

Real-world behavior	Health time preference	Monetary time preference
Flu shot acceptance ( $n = 679$ )	.06	.12**
Retirement investment ( $n = 169$ )	.05	-.14§

Note. Correlations are coded so that positive correlations are in the predicted direction and negative correlations are in the counterpredicted direction.

§  $p < .10$ . \*\*  $p < .01$ .

Time preferences were expected to be particularly predictive of flu shot acceptance among those people who view the flu as a delayed event (which implies seeing flu prevention as a delayed benefit). To test this prediction, we looked for an interaction between time preference and expected delay before contracting the flu. A logistic regression was performed using flu shot acceptance as the dependent measure. The independent variables included both scenario time preference measures and interactions between each time preference measure and the expected delay item. Neither interaction was significant (odds ratios  $< 1.05$ ,  $ps > .32$ ). Thus, among those who expected the flu to occur later, the relationship between time preference and flu shot acceptance was no stronger than it was among those expecting the flu to occur sooner.

**Relationship between time preference and retirement investment.** Wave 2 participants who completed the Spring 2000 questionnaire indicated whether they made voluntary contributions to their retirement fund. We compared those who responded yes with those who responded no (excluding from analyses those who had contributed in the past but weren't presently doing so, those who didn't know, and those who reported not having the option of contributing). Table 1 shows the correlation between retirement contribution and each time preference measure. Investment was marginally correlated with monetary time preference ( $r = -.14$ ,  $N = 169$ ,  $p = .07$ ), but in the direction opposite of our prediction, with high positive discount rates predicting investment contributions. Investment was not related to health time preference ( $r = .05$ ,  $N = 169$ ,  $p = .49$ ). Those who did make retirement investments were asked the percentage of their salary that they contributed. The percentage contributed was not correlated with monetary ( $r = -.15$ ,  $N = 68$ ,  $p = .21$ ) or health time preference measures ( $r = .06$ ,  $N = 68$ ,  $p = .61$ ).

**Test-retest reliability.** For the Wave 2 participants, the correlation between responses to the monetary-time preference scenario in the original questionnaire and those for the retest questionnaire (1 year later) was 0.39 ( $N = 152$ ,  $p < .0001$ ). For the health scenario, the reliability was 0.26 ( $N = 151$ ,  $p = .001$ ). These correlations were significant but modest. The correlation between self-reports of flu shot acceptance on the two questionnaires was 0.61 ( $N = 132$ ,  $p < .0001$ ).

### Discussion

Study 1 revealed very little relationship between scenario measures of time preferences and the health behavior of flu shot acceptance. The monetary time preference measure showed a

small correlation with flu shot acceptance, but the health time preference measure did not. In addition, the relationship between time preference scenario responses and vaccine acceptance was not augmented for those participants who expected a delayed benefit of vaccination. Chapman and Coups (1999) also found a small relationship between flu shot acceptance and a monetary time preference measure, but they did not find the same relationship for two other time preference measures. Thus the findings of the current study are quite similar to those of Chapman and Coups. In both studies it was monetary time preference and not health time preference that was related to flu shot acceptance, and the size of the relationship in the two studies is quite comparable. Chapman and Coups speculated that their small effect size might be caused by the skewed distribution of their time preference measure, leading to poor sensitivity. In the current study, the time preference measures showed close-to-normal distributions, suggesting that the small effect size is not an artifact of the distribution of the time preference measures.

One interesting aspect of the results of Study 1 is the large number of participants who expressed negative discount rates. Previous studies of time preferences (e.g., Benzion et al., 1989; Thaler, 1981) have usually revealed positive discount rates, except in the evaluation of sequences (Loewenstein & Prelec, 1993). The prevalence of negative discount rates in the current study might have been because of the fact that the scenarios described losses or negative outcomes. Some previous studies have found negative discount rates for losses (Chapman, 1996), especially if the loss engenders dread (Loewenstein, 1987). In a recent study of time preferences for health losses, van der Pol and Cairns (2001) noted that approximately 25% of participants expressed negative discount rates. Study 2, presented subsequently, used scenarios describing gains and found high positive discount rates.

A second interesting aspect of Study 1 is that the relationship between time preference and flu shot acceptance was stronger for the monetary scenario. (Chapman & Coups, 1999, found the same pattern.) The health scenario described a flu illness and was more similar in content to the actual decision of whether to accept the flu shot. Responses to the monetary and health scenarios were only weakly correlated, a result that is consistent with past demonstrations of domain independence (Cairns, 1992; Chapman, 1996; Chapman & Elstein, 1995; Chapman et al., 1999). These previous findings would lead to the prediction that health behaviors such as vaccine acceptance should be more strongly correlated with health scenario-time preference measures than with monetary measures. In addition, retirement investment should be more strongly correlated with monetary scenario-time preference measures than with health measures. Study 1 did not support these predictions. It is possible that the monetary time preference question is a better predictor of vaccination because it presents a more familiar situation and thus elicits more reliable responses. The health-related time preference question might have appeared more hypothetical, leading to less reliable responses that were consequently unrelated to actual behavior. The current study as well as past studies (e.g., Chapman, 1996; Chapman & Elstein, 1995) have found monetary time preferences to be slightly more reliable than health time preferences. This account does not explain why the monetary measure was marginally related to investment in the counterpredicted direction. Another possibility is that the responses to the health-related time preference scenario might have been influ-

enced by factors other than time preference, such as scheduled events with which a flu illness may interfere. Monetary responses may be less influenced by such considerations. In a pilot study, however, we found no relationship between time preference responses and participants' reports of scheduled activities.

Because the relationship between scenario measures of time preference and vaccine acceptance was very small and did not occur consistently on both measures, we examined the reliability of the two types of measures. Flu shot acceptance was quite consistent from year to year. Scenario time preference measures showed moderate but significant test-retest reliability. Test-retest measures with a 1-year interval likely represent a conservative measure of reliability. In an unpublished pilot study by Chapman, 14 outpatients from a hypertension clinic answered four time preference questions (two monetary and two health) and repeated the questions at a second session about 2 weeks later. With this shorter retest interval, the test-retest correlation was .73. Simpson and Vuchinich (2000) assessed the reliability of monetary discount rates from 17 healthy adults. At a 1-week retest interval, the reliability was .84. Other studies have used multiple monetary and health time preference questions (which vary in the time delays and magnitude of the outcomes) and found high reliability within each domain (Chapman, 1996; Chapman & Elstein, 1995; Chapman et al., 1999). In a study by Chapman (1996), for example, the average correlation between multiple monetary discount rates was .82; for health the correlation was .64. Taken together, this evidence indicates that scenario measures of time preference show a high level of consistency within a domain and across short time intervals, but that longer retest intervals diminish reliability.

In summary, although we detected a small relationship between time preference and flu shot acceptance, this relationship appeared only for the monetary time preference measures and was not replicated for retirement investment. Thus, scenario measures of time preference do not appear to be strongly related to real world behavior. This lack of relationship is unlikely to be due to low reliability of individual measures. Instead, it appears to reflect a lack of correspondence between different measures of time preference (hypothetical scenarios vs. real world behavior), similar to the domain independence documented in previous studies.

### Study 2: Hypertension Medication

Study 1 examined a health behavior that occurs at most once per year. Each Fall, people have the chance to make a decision about receiving a flu shot. Once they have made their choice, there are no other decisions to be made about flu shots until the following year. Similarly, decisions about retirement investments are made in response to an annual query. Many real-world health behaviors occur much more frequently than this. Exercising, eating a healthy diet, resisting the urge to smoke, and taking needed medication all involve a trade-off between a short-term pleasure and a long-term benefit. Unlike a flu shot decision, these trade-offs are made daily, perhaps almost continuously.

It is unclear whether frequent or infrequent health behaviors would be more likely to reflect underlying time preferences. On the one hand, a decision that is made infrequently may receive more consideration and consequently be a better indicator of decision-theoretic components such as costs, benefits, and time preferences. On the other hand, frequent behaviors are a constant

part of everyday life such that people have many opportunities to think about them and to form preferences and decision strategies. Consequently, it is possible that more repetitious preventive health behavior may be a better indicator of time preferences. Studies 2 and 3 examined one such repetitious health behavior: taking medication for an asymptomatic condition. We examined adherence to medication prescribed for hypertension (high blood pressure) in Study 2; cholesterol-lowering medication was the subject of Study 3.

Hypertension is the leading risk factor for coronary heart disease and also increases risk for stroke and kidney failure. The risk of a heart attack or stroke is small during a narrow time window (e.g., the next few months). Across a long time span (e.g., the rest of one's life), the risks accumulate to form a serious threat. Consequently, treating hypertension has little immediate benefit, because one is very unlikely to suffer the consequences of untreated hypertension in the near future. Treatment conveys large long-term benefits however, as it lowers the lifetime risk of heart attack, stroke, and kidney failure.

In addition to the small immediate benefits, medical treatment of hypertension also carries immediate costs. Because hypertension is an asymptomatic condition (the "silent killer"), the medication used to treat it does not make patients feel better. In fact, because the medication can cause side effects, it may actually make patients feel worse than they did before starting treatment. Thus, adhering to blood pressure-lowering medication carries costs that commence immediately but benefits that accrue only in the future. In this way it is similar to many other preventive health behaviors. As a consequence, engaging in this behavior constitutes an intertemporal choice. Christensen-Szalanski and Northcraft (1985) proposed that poor medication compliance can be understood as reflecting a high discount rate.

The primary purpose of Study 2 was to examine the relationship between medication adherence and scenario measures of time preference. A secondary purpose was to assess the validity of the scenario time preference measures through the use of a series of check questions described later.

## Method

### Participants

The participants were 195 community-dwelling older adults being treated for hypertension. They were a subsample from a larger sample of 458 people participating in an interview study between Fall, 1997 and Spring, 1998. Of these, 195 had a history of hypertension and were currently taking medication to treat their hypertension. They received the version of the interview that was used in the current study. Sixty-five percent of these participants were female, and the mean age at the time of the interview was 79.2 (range = 62-97).

### Procedure

Participants were interviewed individually by trained interviewers. The majority were interviewed in person in their homes, and a minority (5%) were interviewed over the phone. The interview included scenario-based time preference measures and a set of validity check questions designed to assess whether the time preference measures behaved as intended. Medication adherence was measured with self-report, pill count, and blood pressure control.

*Scenario measures of time preference.* Time preferences were measured with trade-off scenarios like those in Study 1. One scenario described a heart disease situation (chest pain), and a second scenario described a financial situation. The chest pain scenario read as follows:

Imagine that you have high blood pressure and suffer from angina or chest pain. About 3 times per day (20 times per week) you feel pain in one side of your chest. This minute-long pain causes you to wince and stop whatever you are doing, and sit quietly for about 5 minutes. Your doctor says you should start taking for the next several years either one of two new medications to reduce your angina. Either medication is provided free of charge and both have only minor side effects. Your doctor says both medications are very effective in preventing heart attack or other serious events. But the medications differ in how much they reduce your pain and when this pain reduction occurs.

Medication A. Your chest pain is reduced from 20 to 16 times per week, starting today.

Medication B. Your chest pain is reduced from 20 to 8 times per week, but this doesn't start until 6 months from now.

That is, Medication B is more effective in reducing angina than Medication A, but it starts working 6 months later. (Remember, both medications are equally effective in preventing a heart attack.) Which medication would you choose?

Depending on the participant's choice, the occurrence of pain for Medication B was increased or decreased. For example, if the participant preferred Medication A, Medication B was then described as reducing pain from 20 to 4 times per week (making B more effective). If the participant initially preferred Medication B, it was made less effective and described as reducing pain only from 20 to 12 times per week. A series of four such choices was presented. The respondent's indifference point was defined as the largest effectiveness of the delayed medication (B) which was not preferred to the immediate option. For example, suppose a participant preferred the immediate medication that was 20% effective (that is, it reduced chest pain from 20 to 16 times per week, or 20%) to a 70%-effective medication in 6 months. If the participant also preferred a 75%-effective medication in 6 months to the 20%-effective medication now, the indifference point would be defined as 70% effective. Medication indifference points were calculable for 187 participants.

The financial scenario was presented as follows:

Imagine that you have just heard from the IRS. They are correcting an error they made and will send you an unexpected cash rebate. Suppose you had a choice about when to get this cash.

Choice A: You receive \$200 in cash today.

Choice B: You receive \$600 6 months from now.

That is, in Choice B the rebate is larger than Choice A, but you would get it 6 months later. Which would you choose?

As in the previous scenario, a series of four choices was asked, with the amount of money provided by Choice B titrated as a function of the respondent's previous choice. The respondent's indifference point was defined as the largest amount of money offered by the delayed option (B) which was not preferred to the immediate option. Monetary indifference points were calculable for 194 participants.

On average, \$382 ( $\pm$ \$225) to be received in 6 months was viewed as just as preferable as \$200 now (median \$300, interquartile [IQR] \$250–\$400). An immediate angina treatment that was 20% effective was viewed as just as attractive as a treatment commencing 6 months from now that was, on average, 70% ( $\pm$ 28%) effective (median 80%, IQR 40%–100%). Thus, waiting 6 months for a sum of money required a 91% increase in the amount of money (from \$200 to \$382, corresponding to a 265% annual discount rate). Waiting 6 months for a medication to start working required a 250% increase in the effectiveness of the medication (from 20% to 70%,

corresponding to an 1,125% annual discount rate).<sup>3</sup> That is, the discount rate applied to medication was larger than that applied to money,  $t(186) = 13.92, p < .0001$ .

*Validity check questions.* After each of the time preference scenarios, participants rated a series of statements to indicate "how much you thought about this when making your decision." The items are shown in Table 2, and each was rated on a 5-point scale that ranged from 1 (*not at all*) to 5 (*very much*). Some of the items (Items 1, 2, 6, and 7 in Table 2) were designed to assess whether participants considered the intertemporal trade-off when responding to the scenarios. The remaining items assessed whether other influences contaminated scenario responses. Mean responses to each item are shown in Table 2.

*Measures of medication adherence.* Participants' adherence to their medication regimens was measured in three ways. First, participants were asked about their medication-taking behavior. Second, a pill count measure was taken, and third, blood pressure measures were recorded.

*Self-reported adherence.* Participants were asked a series of questions about how they took their medication to control hypertension. Participants who took multiple medications for hypertension were asked about each one. Participants indicated the prescribed dose per day and how many days in the past week they had (a) decided to take less than the prescribed dose, (b) taken less than the prescribed dose because of a mistake, (c) decided to take more than the prescribed dose, or (d) taken more than the prescribed dose because of a mistake. Respondents also answered three summary items by indicating over the past week, the past month, and the past 6 months, "how often have you taken your blood pressure medication exactly as prescribed?" Responses to these items were given on a 5-point scale ranging from 1 *never* to 5 *always*.

In the four specific questions about the frequency in the past 2 weeks that participants had taken more or less than the prescribed dose, reported deviations from the prescribed dose were rare. Consequently, responses to these questions were combined into a single dichotomous score called the *specific self-report score*. Participants who reported no deviations from the prescribed dose on any medication were placed in the compliant category ( $N = 151$ , or 77% of 195), and those who reported at least one type of deviation on at least one medication were placed into the noncompliant category ( $N = 44$ , or 23% of 195).<sup>4</sup>

In the three summary questions about the extent to which participants took their medication exactly as prescribed, the percentage of respondents who answered always was very high (80% or more). The correlations among the three items ranged from .57 to .82. Thus, the three items were averaged together to form a single summary self-report score.

*Pill count.* For the pill count measure, several pieces of information were recorded for each medication the participant took for hypertension. The date the participant started using the current refill and the prescribed dose per day were used to compute the *target* number of pills that should have been taken by the interview date. The number of pills provided in the last refill and the number of pills currently in the bottle were used to compute the actual number of pills that the participant had *consumed*. A measure of pill count compliance was computed as  $\text{consumed} \div \text{target}$ , producing a ratio where 1.0 means perfect compliance, numbers less than 1.0 mean underuse, and numbers greater than 1.0 mean overuse. If the participant was taking multiple antihypertensive medications, the scores from all medications are averaged. Medication names were reviewed by a physician to confirm that they were indeed antihypertensive medications.

<sup>3</sup> Unlike the financial scenario, the health scenario described a stream of outcomes (chest pain episodes per week over the next several years). Consequently, the health discount rate was computed using an annuity calculator with a 60-month time horizon. Changes in the time horizon from 60 to 36 months had negligible effects on the discount rate.

<sup>4</sup> If only self-report items on missed medication were included in this score, the categorization of 1 participant would be altered.

Table 2  
Correlations Between Time Preference Measures and Validity Check Questions in Study 2

Check questions	M (and SD) ratings <sup>a</sup> (n = 194)	Correlation with time preference measure	
		Chest pain (n = 187)	Monetary (n = 194)
Chest pain scenario			
1. I would want to have relief right away.	3.44 (1.29)	.45**	.06
2. The medication that takes 6 months to work is more effective in reducing pain, so worth waiting for.	2.72 (1.37)	-.52**	-.23**
3. I'd want to be sure the medication would keep me from having a heart attack.	3.89 (1.32)	.09	-.05
4. It might be dangerous for my health to wait 6 months for medicine B to take effect.	3.03 (1.52)	.47**	.12
5. I thought "Who knows if I'll be around in 6 months?"	2.65 (1.67)	.46**	.20**
Monetary scenario			
6. Waiting for the delayed money is like earning a high rate of interest.	2.80 (1.56)	-.21**	-.27**
7. The delayed amount is more money, so worth waiting for.	3.57 (1.31)	-.26**	-.45**
8. I need the money right away; I have bills to pay.	1.37 (0.81)	.19*	.28**
9. I thought "Who knows if I'll be around in 6 months?"	1.75 (1.22)	.47**	.48**

<sup>a</sup> Ratings are on a 5-point scale.

\*  $p < .05$ . \*\*  $p < .01$ .

Forty-three of the 195 participants (22%) did not show the interviewer any medications because they were interviewed over the phone, or had no antihypertensive medications to show the interviewer, or did not agree to show any. Thus, pill count compliance scores could be computed for the 152 participants who had at least one medication. Nineteen of the participants (12.5%) had a pill count compliance score greater than 1.0, indicating overuse of the medication. Because it was unclear whether to categorize these participants as adherent, nonadherent, or superadherent, pill count scores for these participants were coded as missing. (See Footnote 6.) After this conversion, the mean pill count compliance score was 0.64 (range = 0.00–1.00; Mdn = 0.73).

**Blood pressure.** During the interview, an automatic cuff was used to take three blood pressure measurements separated by 10-min intervals. A composite measure of blood pressure was formed by taking the average of the second and third measurements. The average systolic pressure was 145 mm Hg and the average diastolic pressure was 75 mm Hg (written as 145/75). According to this measure, 41.5% of participants (76 of 183) had controlled blood pressure in that their systolic blood pressure was below 140 and their diastolic blood pressure was below 90 (National Heart, Lung, and Blood Institute, 1997). The remaining 58.5% had uncontrolled blood pressure despite being on medication.

Participants were given a mailback form to take to their next doctor's visit so that their doctor could record their blood pressure from that visit. Sixty-four percent of participants (124 of 195) mailed back the form within a time frame of 1 year. Measurements taken in the doctor's office differed slightly from those taken during the interview ( $M = 143/79$  doctor vs.  $144/74$  interview), and two were only moderately correlated ( $r = .36$  for systolic pressure and  $.48$  for diastolic pressure;  $N = 124$ ,  $p < .0001$ ). Consequently, doctor- and interview-blood pressure measurements were retained as separate measures of blood pressure control.

## Results

**Relationship between the time preference measures.** We first examined the relationships between the monetary and health time preferences from the trade-off scenarios. As in Study 1, these were only moderately correlated ( $r = .26$ ,  $N = 187$ ,  $p = .0004$ ).

**Validity check of time preference measures.** We next examined the validity check items. Table 2 presents the mean ratings and the correlation between each item and the time preference

measures. One participant was missing responses to all nine validity check items and was removed from this analysis. A few additional missing values (0.2%) were replaced with item means.

As shown on the top of Table 2, of the five items rated following the chest pain scenario, two (Items 1 and 2 on Table 2) assessed whether participants thought about the trade-off between magnitude of chest pain relief and time delay, the concept that should be measured by the time preference scenarios. Three additional items assessed factors that might have influenced responses to the scenario but which do not comprise time preference. Two of these (Items 3 and 4) assessed whether participants thought that waiting for the delayed medication might be dangerous or increase the risk of a heart attack. Agreement with these items represents a misunderstanding because the scenario stated that the two medications were equally effective in preventing a heart attack. Item 5, the final item, assessed perceived uncertainty about surviving long enough to reap the benefits of the delayed medication. Although time delay can introduce uncertainty, the current scenarios were designed to discourage this inference. The effects of uncertainty on decision making are logically distinct from the direct effects of time delay and are therefore treated as separate theoretical constructs (Gafni & Torrance, 1984).

The mean ratings of the five chest pain items were similar. The average of the two "true time preference" items (1 and 2) did not differ from the average of the three comparison items (3, 4, and 5),  $t(193) = 1.20$ ,  $p = .23$ . Both of the true time preference items were correlated in the predicted direction with the time-discounting measure from the chest pain scenario. Two of the three comparison items were also correlated with scenario responses.

As shown at the bottom of Table 2, of the four items rated following the monetary scenario, two (Items 6 and 7) assessed intertemporal trade-offs, and two comparison items (8 and 9) assessed other factors that might influence scenario responses—cash flow constraints and uncertainty about surviving long enough to receive the delayed money. The average of the two true time preference items (6 and 7) was larger than the average of the two comparison items (8 and 9),  $t(193) = 13.67$ ,  $p < .0001$ . Both of the

true time preference items were correlated in the predicted direction with the time-discounting measure from the monetary scenario. Both of the comparison items were also correlated.

These analyses suggest that both chest pain and monetary scenario responses reflect intertemporal trade-offs as intended, but that they also reflect influences of additional factors. It is possible, however, that participants responded to the check questions in such a way as to be consistent with the time preference choices they had just made rather than revealing the motivations behind those choices. Nonetheless, these correlations establish that moderate associations can be detected between the scenario responses and other variables.

*Relationships among the adherence measures.* We examined the relationships among five adherence measures of medication compliance: the specific self-report score based on the items about the number of days when a medication dose was missed or increased, the summary self-report score based on the global items about how often one took the medication exactly as prescribed, the pill count score, blood pressure measured during the study interview, and blood pressure measured at a doctor's office. For the blood pressure measures, systolic pressure (rather than diastolic) was used because it is the indicator used as the basis for treatment (Black, 1999; Lloyd-Jones, Evans, Larson, O'Donnell, & Levy, 1999). Virtually identical correlations were obtained if diastolic blood pressure was used instead in the analysis.

The correlations among these five measures are shown in Table 3. Correlations in Table 3 were based on an  $N$  of 128, which included all participants who had complete data on all time preference and adherence measures, with the exception of doctor's visit-blood pressure readings (which were available for only two thirds of participants). Variables were coded such that positive correlations are in the direction expected, and negative correlations are in the counterpredicted direction. Of the 10 correlations among adherence measures, 8 were in the predicted direction, 5 of those were significant, and 2 were marginal. The two correlations in the counterpredicted direction were between pill count and blood pressure. Although it is not clear why these correlations would be negative, it is possible that participants with more severe hypertension (higher blood pressure before treatment) were more adherent in taking their medication. Apart from these two correlations, there was a moderate amount of agreement among the adherence measures, although the Cronbach's alpha was only 0.32. Removing pill count increased the alpha only negligibly to 0.34.

*Relationship between time preference scenario responses and medication adherence.* Of primary interest was the relationship between the scenario time preference measures and the adherence measures. We examined the 10 correlations that resulted from pairing both time preference measures with each compliance measure. As stated earlier, so that all correlations would be based on the same set of participants, we excluded those who were missing either of the time preference measures or any of four adherence measures, thus ensuring that changes in the sample composition could not be a potential explanation of differences between correlations. We did not exclude participants who were missing doctor's visit-blood pressure readings. Thus, 8 of the 10 correlations between time preference and adherence were based on an  $N$  of 128. Correlations involving doctor's visit-blood pressure readings were based on a sample size of 89.<sup>5</sup> A sample size of 128 allowed for the detection of correlations of .24 or larger with an alpha of 0.05

and a beta of 0.20 (a sample size of 89 allowed for detection of correlations of .29).

Table 3 shows the correlations. Variables were coded such that positive correlations are in the direction expected and negative correlations are in the counterpredicted direction. Seven of the 10 correlations were in the predicted direction, 1 was significant, and 2 were marginal. The one significant correlation was that between responses to the chest pain time preference scenario and pill count. As explained earlier, 19 participants had pill count scores exceeding 1.0, and these scores were converted to missing, meaning that these participants were excluded from the results in Table 3. Some alternate methods of handling these participants resulted in the reduction of this correlation.<sup>6</sup> Consequently, the correlation reported in Table 3 might be an overestimate. Responses to the chest pain time preference scenario were marginally correlated with the specific self-report score and with blood pressure measured at the doctor's office. Responses to the monetary time preference scenario were not significantly correlated with any adherence measure. Thus, the correlations revealed only suggestive evidence of a relationship between scenario time preference measures and adherence to blood pressure medication. The agreement between time preference measures and among adherence measures suggests that the poor relationship between these two groups of variables is not entirely due to unreliability in either group of measures.

We conducted an omnibus test of the relationship between time preference and adherence. The health and monetary time preference measures were averaged, and this combined measure was regressed on four adherence measures: specific self-report, summary self-report, pill count, and interview blood pressure. (Doctor's visit blood pressure was not included because doing so would have entailed excluding the one third of participants who did not provide this measure.) The  $r^2$  of the model (0.05) was not significant,  $F(4, 124) = 1.80$ ,  $MSE = 1.05$ ,  $p = .13$ . Pill count was the only adherence measure to be individually related to the combined time preference measure,  $F(1, 124) = 5.90$ ,  $MSE = 1.05$ ,  $p = .02$ . Including doctor's visit blood pressure in the regression did not increase the  $r^2$  (0.04),  $F(5, 87) = 0.72$ ,  $MSE = 1.10$ ,  $p = .61$ . Using the chest pain time preference measure (rather than the combined measure) as the dependent variable increased the  $r^2$  only slightly (0.06),  $F(4, 123) = 2.11$ ,  $MSE = 1.41$ ,  $p = .08$ . Thus, the omnibus test showed very little relationship between scenario measures of time preference and adherence.

<sup>5</sup> An alternative method is to compute each correlation based on all participants who have values for both variables. By using this pairwise deletion method, each correlation is based on a different  $N$ . Correlations computed in this manner were very similar to those presented in Table 3 and did not alter any conclusions.

<sup>6</sup> Converting overadherence to perfect adherence (1.0) for example, reduced the correlation to .10, ( $N = 147$ ,  $p = .23$ ), and leaving overadherence pill count scores as is reversed the correlation to  $-.10$  ( $N = 147$ ,  $p = .23$ ). Coding all pill-count scores as absolute deviation from 1.0 resulted in a correlation similar to that shown in Table 3 ( $r = .21$ ,  $N = 147$ ,  $p = .01$ ).

Table 3  
*Pearson Correlations Among Time Preference and Medication Adherence Measures in Study 2*  
 (N = 128)

Measure	Time preference		Adherence				
	1	2	3	4	5	6	7
Time preference							
1. Health scenario	—						
2. Monetary scenario	.27**	—					
Adherence							
3. Self-report, specific	.17†	-.04	—				
4. Self-report, summary	.13	-.03	.40**	—			
5. Pill count	.21*	.06	.15§	.21*	—		
6. Blood pressure, interview	-.01	.07	.05	.24**	-.09	—	
7. Blood pressure, doctor's visit <sup>a</sup>	.18§	.04	.18§	.27*	-.09	.34**	—

Note. All correlations are coded so that positive correlations are in the predicted direction and negative correlations are opposite to the predicted direction.

<sup>a</sup> n = 89 for this row.

§ p < .10. † p < .06. \* p < .05. \*\* p < .01.

### Discussion

Study 2 examined an expanded set of preventive health measures. Unlike Study 1 which included only a single measure of health behavior, Study 2 included five measures of medication adherence, including two types of self-report measures, a pill count measure, and two types of blood pressure control measures. Study 2 thus provided more opportunities for detecting a relationship between scenario measures of time preference and preventive health behavior. Limitations in any one measure of adherence could potentially be counteracted by the use of alternative measures. As in Study 1, in Study 2 we measured both health and monetary time preferences by using trade-off scenarios in which participants made choices between an immediate and a delayed outcome. In this study, the health scenario was tailored to be relevant to heart disease, a disease that can be prevented through blood pressure control. In addition, time preference scenarios were followed by validity check questions which indicated that scenario responses did incorporate intertemporal trade-offs.

Despite these strengths in design, Study 2 uncovered no more evidence of a link between scenario measures of time preference and health behaviors than did Study 1. Only 1 of the 10 correlations examined was significant, and it was sensitive to the method of coding pill count. Two other correlations were marginal but of small magnitude. Interestingly, only the chest pain scenario responses showed any evidence of a relationship to adherence; responses to the monetary scenario showed near-zero correlations with every adherence measure. In contrast, Study 1 found suggestive evidence of a relationship between discount rate and health behavior only for the monetary time preference measure. It is possible that the chest pain scenario in Study 2 was more relevant to participants' behavior than was the flu illness scenario in Study 1. Study 2 is in agreement with Study 1, however, in indicating that there is little relationship between time preference scenario measures and preventive health behavior. What little evidence there is for this relationship indicates a weak association that appears only for some measures of time preference and health behavior.

### Study 3: Cholesterol Medication

Study 3 examined adherence to another type of medication that used to control high cholesterol. Like hypertension, high cholesterol is a symptomless condition that increases the risk of heart attack and stroke. Cholesterol medication has little immediate benefit, because one is very unlikely to suffer the consequences of untreated high cholesterol in the near future. Treatment provides large long-term benefits, however, by reducing the lifetime risk of heart attack and stroke. As with hypertension, the medication does not make the patient feel any better (because the condition is symptomless) and often causes side effects, the most common being gastrointestinal discomfort. Thus, medical treatment for high cholesterol involves costs that begin immediately but benefits that accrue only in the future. One would consequently expect that adherence to this medication would reflect time preferences.

Whereas we examined older adults recruited through their community in Study 2, we examined a somewhat younger clinic outpatient population recruited through their physicians in Study 3. Both hypertension and high cholesterol become more common with age. The advanced age (and resulting short life expectancy) of some of the Study 2 participants might have influenced the time preference responses and limited the relationship to medication adherence. Study 3 ameliorated this problem by using a somewhat younger participant group.

### Method

#### Participants

The participants were outpatients from a general internal medicine faculty practice at an academic medical center. Computerized medical records from the clinic identified 275 patients with current prescriptions for cholesterol-lowering medication. One hundred sixty-nine of these patients (61% response rate) responded to a mailed questionnaire. The average age of the respondents was 67 (range = 36–85), 61% were men, and 87% were White.

## Procedure

Potential participants were mailed a questionnaire, consent form, and cover letter from one of the clinic physicians. Those who did not respond within 3 weeks were mailed a reminder letter followed by two reminder phone calls. After a participant returned a signed consent form and completed questionnaire, she or he was mailed a movie ticket as our thanks, and the participant's medical chart was read.

**Scenario measures of time preference.** A single item in the questionnaire assessed time preferences. This item was the same chest pain scenario used in Study 2 with a minor alteration. Rather than asking participants to imagine that they suffered from high blood pressure, the scenario asked them to imagine that they suffered from a heart condition that resulted in periodic chest pain. Participants were presented with a single choice between an immediately effective medication that reduced chest pain from 20 to 16 times per week and a medication effective in 6 months that would reduce chest pain from 20 to 4 times per week. Because of space constraints, Study 3 did not include a series of choices to identify participants' indifference points as had been used in Studies 1 and 2. Forty-seven percent of participants preferred the immediate medication and the rest (53%) preferred the medication with delayed benefits.

**Medication adherence measures.** Medication compliance was assessed in two ways: through self-report and through a chart review of the patient's current cholesterol level.

**Self-reported adherence.** Participants provided a self-report of adherence on four questionnaire items. Two items asked how frequently in the past 2 weeks participants had taken more or less than the prescribed dose of medication (either because they forgot or felt they should increase or decrease the dose). Response options were no days, 1 day, 2–3 days, 4–6 days, and 7 or more days. Two additional items asked how frequently they had taken their cholesterol medication exactly as prescribed in the past week and in the past 6 months. Responses were given on a 5-point scale that ranged from 1 (*never*) to 5 (*always*).

The item about the number of increased doses in the past 2 weeks was dropped because 98% of participants answered never. A dichotomous self-reported adherence score was formed from the other three items. Participants were categorized as adherent (69%) if they reported no decreased medication doses in the past 2 weeks and responded that they always took their medication exactly as prescribed over the past week and over the past 6 months. Participants who reported less than perfect adherence on any one of the three items were categorized as nonadherent (31%).

**Cholesterol levels.** A second measure of medication adherence came from the medical chart review. We recorded each patient's most recent cholesterol test that included a low-density lipoprotein (LDL) count, the component of cholesterol that is targeted when antihyperlipidemic drugs are prescribed (National Cholesterol Education Program, 1993). The National Cholesterol Education Program's (NCEP) guidelines for treatment of hypercholesterolemia were used to establish treatment targets or maximum LDL cholesterol levels for each patient (National Cholesterol Education Program, 1993). An LDL compliance score was computed for each participant by subtracting the target LDL level from the participant's actual LDL level (for details, see Brewer, Chapman, Brownlee, & Leventhal, in press). Higher values of this difference score indicated less success in meeting target levels, and negative values indicated that the participant's LDL level was actually below the target level. The mean LDL level across participants was 119 ( $SD = 35$ ) and the mean LDL compliance difference score was  $-25$  ( $SD = 38$ ), and ranged from  $-109$  to  $92$ . Twenty-three percent of the participants had LDL levels that exceeded target levels.

## Results

Of the 169 respondents, 137 had complete data on the three variables of interest: time preference, self-reported adherence, and current LDL levels. Only these participants were used in analyses.

With this sample size, we had the power to detect correlations of .24 or larger.

**Relationship between measures of adherence.** First, we compared the two measures of adherence. Self-report of adherence and LDL compliance scores were moderately correlated with one another ( $r = -.22$ ,  $N = 137$ ,  $p = .008$ ). Among those coded as adherent by self-report, the mean LDL compliance score was  $-30$  ( $SD = 36$ ), which was more adherent than the mean ( $M = -13$ ,  $SD = 40$ ) for those coded as nonadherent by self-report,  $t(135) = 2.56$ ,  $p = .008$ . Thus, adherence shows some degree of intermeasure agreement.

**Relationship between time preference and adherence.** To address the question of primary interest, we assessed the correlation between responses to the time preference scenario and each of the two measures of medication adherence. First, in terms of the composite self-report adherence score, among those who preferred the immediate medication in the time preference scenario ( $n = 65$ ), 75% were categorized as adherent compared with 62% of those ( $n = 72$ ) who preferred the medication with delayed effects. This difference was not significant,  $\chi^2(1, N = 137) = 2.63$ ;  $\phi = -0.14$ ,  $p = .14$  and, in any case, was in the direction opposite to prediction. We predicted that those who preferred the larger, delayed medication effect (demonstrating a high value for future outcomes) would be more compliant. This pattern was not found. Second, the LDL compliance scores of those who preferred the immediate medication in the time preference scenario ( $M = -24.3$ ,  $SD = 42$ ) did not differ from those who preferred the delayed medication ( $M = -25.64$ ,  $SD = 33$ ),  $t(135) = 0.21$ ,  $r = -.02$ ,  $p = .50$ .

Finally, we examined the relationship between time preference and a combination of the two adherence measures. LDL compliance scores were converted to a 0–1 range, where 1 indicated higher adherence. This transformed score was then averaged with the self-reported adherence score (coded as 0 or 1). The correlation between the resulting combination score and time preference was  $-.11$  ( $N = 137$ ,  $p = .19$ ), which was opposite to prediction in direction and not significant. Thus, no comparisons showed a detectible relationship between choices in the time preference scenario and adherence to cholesterol-lowering medication.

## Discussion

Study 3 found no relationship between responses to a time preference scenario and adherence to a cholesterol-lowering medication regimen. Participants who were willing to accept delayed relief from chest pain were no more likely to report taking their medication as prescribed than those who chose the immediate angina relief. In addition, the two groups did not differ in the LDL compliance scores, which is the outcome that the medication is meant to affect. Thus, the results from Study 3 were quite consistent with those from Study 2 in that both found little or no relationship between time preference scenario measures and adherence to a treatment regimen for an asymptomatic condition that poses a long-term health threat.

## GENERAL DISCUSSION

The current studies revealed little correspondence between scenario measures of time preferences and preventive health behavior. Study 1 did find a significant correlation between flu shot accep-

tance and the monetary time preference measure, but this correlation was quite small, and the health scenario time preference measure was unrelated to flu shot acceptance. In Study 2, the chest pain scenario measure of time preference was correlated with one of five measures of medication adherence (pill count) and marginally related to two other measures. The relationship with pill count, however, was sensitive to how this variable was coded. In addition, the remaining adherence measures were unrelated to responses to the chest pain scenario, and none of the adherence measures were related to responses to the monetary time preference scenario. Finally, Study 3 found no relationship between the heart disease scenario measure of time preference and two measures of medication adherence. Thus, although the current studies did detect a relationship between scenario measures of time preference and preventive health behavior in a few cases, this relationship was small and was detected for only a minority of the measures used. Most scenario choices and health behaviors showed no relationship with one another.

These findings are surprising because there are strong reasons to believe that both hypothetical intertemporal choices and preventive behaviors would reflect the same underlying time preference. Numerous everyday decisions (e.g., taking medication, dieting, exercising) pit short-term benefits against long-term benefits, and many problem behaviors (e.g., unsafe sex, not using seat belts, large credit card debt) illustrate a preference for immediate pleasure or convenience over a larger, delayed benefit. The scenario measures used in the current studies and in previous studies pose the same type of intertemporal choices: Respondents must choose between an immediate small outcome and a delayed larger outcome. If decision makers have a general mechanism for resolving intertemporal choices, one would expect that mechanism to operate both in hypothetical scenarios and in real world behaviors.

A number of studies of time preferences have found exceedingly high discount rates (e.g., Ben Zion et al., 1989; Chapman & Elstein, 1995; Chapman et al., 1999; Thaler, 1981), indicating that future outcomes are given little weight. This finding is consistent with the fact that people are often reluctant to adopt preventive health behaviors or to engage in other future-minded activities, such as investing for retirement or studying in advance for an exam. That is, high discount rates seem to have the potential to explain the paucity of everyday choices that favor long-term consequences.

If both hypothetical choices and real-world behavior reflect a common mechanism, then variations in time preference expressed in hypothetical scenarios should correspond to variations in behavior. That is, individuals showing especially high discount rates in hypothetical choices should be especially unlikely to engage in preventive behavior. Likewise, situations or domains that elicit especially low discount rates should be especially likely to evoke preventive behavior. The current studies found very little in the way of such correspondence. Thus, although it may seem plausible that hypothetical intertemporal choices and preventive health behavior reflect a common mechanism, there is surprisingly little empirical evidence to support this claim.

#### *Connection to Previous Research*

The findings from the current studies are consistent with much of the previous research conducted on this topic. For example, Fuchs (1982) found that temporal discount rates were weakly

correlated with only one of the health behaviors examined. Chapman and Coups (1999) found results consistent with Study 1: The monetary scenario measure of time preference bore only a small relationship to flu shot acceptance and this same relationship was not apparent for the health scenario measure. Chapman (1998) reported two studies in which measures of time preference were unrelated to preventive behavior. One examined two measures of adherence to hypertension treatment: pharmacy records of prescription refills and medical appointments kept. The second examined exercise behavior, which was unrelated to multiple time preference measures. Thus, the results from the current studies are consistent with several past studies showing only a very small or no relationship between scenario time preference measures and preventive health behavior.

The previous literature does indicate some variation across behaviors in their relationship to measures of time preference, however. As reviewed in the introduction, previous research found a reliable relationship between time preference and addiction behaviors, such as smoking or heroin and alcohol use (Bickel et al., 1999; Fuchs, 1982; Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998; but see, Chesson & Viscusi, 2000). Thus, addiction apparently bears a special relationship to time preference. It is currently unclear why substance abuse shows a relationship to hypothetical choice measures of time preference when other behaviors do not. One possibility is that substance abuse, rather than simply reflecting time preferences, actually influences them (perhaps through chemical actions on the brain). A second possibility is that the association between time preference measures and addiction is an artifact of the case-control design used in these studies—specifically, addicts and controls may have differed in factors other than their addiction status.

An alternative possibility is that some classes of behaviors reflect time preferences but not others. For example, “hot,” emotional, or impulsive behaviors may reflect time preferences more so than “cool,” deliberate, or habitual behaviors (e.g., Metcalfe & Mischel, 1999). A related possibility is that health-damaging behaviors (e.g., smoking, substance use) may reflect time preferences more so than health-enhancing behaviors (e.g., flu shots, taking medication). Exploration of these possibilities awaits future research.

#### *Reliability of Measures*

Null findings, such as the lack of relationship between time preference scenario responses and health behavior found in the current studies, raise questions about the reliability of the measures used. Hypothetical choice measures that are unreliable would not be expected to predict health behavior. There are several reasons to believe that the time preference measures used in the present studies did in fact have sufficient reliability.

Study 1 included a test-retest reliability check of the scenario measures and revealed moderate but significant reliability. As discussed in Study 1, the year-long retest interval likely resulted in a conservative estimate of reliability. Previous studies using a short retest interval (Simpson & Vuchinich, 2000) or multiple monetary and health time preference questions (Chapman, 1996; Chapman & Elstein, 1995; Chapman et al., 1999) have found excellent reliability within each domain. The measures used in the current studies were very similar to those used in these previous studies.

Although the current studies showed little or no relationship between time preference scenario measures and preventive health behaviors, further evidence indicates that it is possible to detect relationships between time preference scenario responses and other variables. Study 2, for example, found moderate correlations of about .45 between time preference measures and the validity check questions used in that study. As mentioned previously, other studies (Bickel et al., 1999; Fuchs, 1982; Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998) have found sizable correlations between time preference and addiction behaviors, using time preference measures similar to those used in the current studies. For example, Kirby et al. (1999; p. 81) found that discount rates among heroin addicts were twice as large as among controls, an effect size (Cohen's *d*) of 0.57. These studies demonstrate that correlations can be detected between scenario measures of time preference and real-world behavior. Thus, the null findings of the current studies are unlikely to be due to unreliability of the time preference measures.

It is possible that the addiction studies were successful in finding a correspondence among measures, in part, because of a more reliable hypothetical choice measures. Bickel et al. (1999), Madden et al. (1997), and Vuchinich and Simpson (1998) used a 30-min interview to administer a hypothetical monetary-choice task that identified the amount of money to be received immediately that was equivalent to a magnitude of delayed money. Each participant made a total of 480 choices to establish 16 indifference points (one for each of two magnitudes and eight delays) which were used to fit discounting functions. This lengthy procedure yielded very reliable estimates of temporal discounting (Simpson & Vuchinich, 2000), perhaps more reliable than briefer measures. Another addiction study (Kirby et al., 1999), however, did not use this lengthy procedure, yet still found a large relationship between discounting and addiction status. Kirby et al.'s participants made only 27 choices, resulting in three indifference points. The study nevertheless revealed a large relationship between these indifference points and level of addiction status, suggesting that even this abbreviated procedure yielded a reliable measure. Kirby et al.'s procedure is quite comparable to that of Study 1 in which participants made 20 or 12 choices (for Waves 1 and 2, respectively), resulting in two indifference points. This similarity in procedure suggests that the current procedures yielded a reliable enough measure of time preferences to detect a relationship with health behavior if one were present.

A notable feature of the time preference measures used in the addiction studies (Bickel et al., 1999; Fuchs, 1982; Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998) is that no scenario was used with the monetary choices. That is, participants were simply asked to choose between differing amounts of money that would be delivered at different times. Unlike the current studies, no cover story such as a parking ticket or a tax rebate scenario was used. The lack of a scenario may have focused participants on the intertemporal trade-off and discouraged them from considering atemporal factors thought to be relevant to the decision. If so, the amount of noise in responses would be reduced and reliability improved.

The time preference measures used in the current study are the same type as those used in numerous previous studies of intertemporal choice (e.g., Ben Zion et al., 1989; Bohm, 1994; Cairns, 1992; Chapman, 1996; Chapman & Coups, 1999; Chapman & Elstein,

1995; Chapman et al., 1999; Thaler, 1981; van der Pol & Cairns, 2001). All of these studies presented decision makers with a scenario describing a trade-off between an immediate outcome and a delayed outcome, and elicited a response that indicated the magnitude of one outcome that would make it equivalent in value to the other outcome. Study procedures differ from one another in some respect, such as the specified delays and magnitudes, the method for eliciting an indifference point, or the cover story that introduces the choice. The intertemporal trade-off presented, however, defines time preference in the decision-making literature. The current studies test whether the trade-off questions used in so many previous experiments are correlated with real-world behavior that exemplifies intertemporal choice, as would be predicted if the trade-off questions reflect a general decision process applied to all intertemporal choices. Our results indicate that responses to intertemporal trade-offs are less related to real-world behavior than might have been expected.

In addition to concerns about the reliability of scenario measures of time preference, one might also be concerned about the reliability in the measures of health behavior. Study 1 included a single measure of health behavior (self-reported flu shot acceptance) which was quite consistent from one year to the next. Studies 2 and 3 included multiple measures of medication adherence. Many of the correlations among these measures were significant but modest. Self-report, pill count, and disease control (e.g., blood pressure or cholesterol levels) are standard measures of medication adherence (Fletcher, Pappius, & Harper, 1979; Maenpaa, Manninen, & Heinonen, 1987, 1992). None provides a perfect reflection of medication-taking behavior. For example, self-report can be erroneous because of faulty memory or a presentation bias, and pill counts can be inaccurate if some pills were lost or stored in another container. Disease control is an indirect measure of medication adherence because even perfect adherence with an ineffective medicine will not result in good control. Because the error components differ for each of these measures, the correlations across measures is only moderate. Alternative adherence measures that are more accurate, such as computerized pill bottles, have the potential to influence the very behavior they are measuring (e.g., patients become more adherent because they know their adherence is being measured). Thus, although the health behavior measures used in the current studies have limitations, they are the standard measures used in the study of adherence. The fact that time preference did not demonstrate a strong correlation with any of the health behavior measures used in any of the studies suggests that the null findings are not due to the unreliability of any single measure.

#### *Reasons for the Lack of Relationship Between Time Preference and Behavior*

Because it would be reasonable to infer that preference for the timing of outcomes is one factor that drives preventive behaviors, it is surprising that the present studies found very little evidence for this connection. Why is this expected association absent? One possibility is that both scenario questionnaire responses and health behaviors are governed by factors other than true time preferences. Responses to the scenarios in Study 2, for example, appeared to be influenced by perceived uncertainty and concerns about safety in addition to pure time preference. Similarly, medication-taking

behavior is influenced by factors such as memory lapses or perceived effectiveness of the medication in addition to time preferences. These additional influences may produce enough variance in both the scenario responses and the health behaviors that relationships between the two cannot be detected. It is possible that if scenarios could be developed and health behaviors identified that provide purer measures of time preference, a correlation between scenario measures and health behavior could be detected.

A second possibility is that time preferences are very context specific and vary so much from situation to situation that a questionnaire measure is not related to real-world behavior. That is, time preferences expressed in a chest pain scenario may be reliable across time and across variations in that scenario; however, the situation of taking blood pressure medication may differ sufficiently from the scenario description that the same time preferences are not used in the two situations. Previous studies have demonstrated domain independence (Cairns, 1992; Chapman, 1996; Chapman & Elstein, 1995; Chapman et al., 1999), the fact that health and monetary discount rates are not well correlated with one another, although discount rates are quite reliable within domains. Because of these past findings, we predicted in Study 1 that flu shot acceptance would correlate more strongly with the health scenario measure of time preference than with the monetary scenario measure, and that retirement fund contributions would correlate more strongly with the monetary scenario time preference measure than with the health scenario measure. This results pattern was not obtained. This finding might indicate that time preferences are even more domain specific than previously thought, such that the discount rate applied to getting a flu shot is not the same as the discount rate applied to a scenario about getting the flu. That is, decision makers do not possess a single discount rate that is broadly applied. Instead, they make intertemporal choices by using decision processes that are very specific to the content and format of the choice. Such an account is consistent with results from Chapman et al. (1999) who found that discount rates for two different health scenarios were not well correlated with each other, demonstrating that time preferences are not consistent across multiple health domains.

### *Other Temporal Attitudes*

The current studies focused on time preferences, or the extent to which outcomes are discounted because of a temporal delay. A number of other temporal attitudes have been the subject of much research. It is beyond the scope of this article to analyze the relationships among time preference and other temporal attitudes. Nevertheless, several studies of temporal attitudes warrant mention because they assessed the relationship between temporal attitudes and real-world behavior.

One example of a relationship between temporal attitude and real-world behavior comes from studies by Mahon and colleagues (Mahon & Yarcheski, 1994; Mahon, Yarcheski, & Yarcheski, 1997) who examined an attitude they called *time perspective*, or the extent to which the future is perceived as predictable, structured, and controllable. This construct was measured with a 25-item inventory that contained items such as "It's really no use worrying about the future, because what will be, will be," "My future seems dark to me," and "I always seem to be doing things at the last moment." This scale was moderately correlated with a

composite measure of health behavior that included exercise, nutrition, relaxation, safety, substance use, and health promotion ( $r$ s ranged from .20 to .52 for different groups of participants).

A second example is the well-known research of Mischel and colleagues (e.g., Mischel, Shoda, & Peake, 1988; Mischel, Shoda, & Rodriguez, 1989; Shoda, Mischel, & Peake, 1990) who examined a temporal attitude known as *delay of gratification*. In the delay of gratification task, Mischel placed a small treat (e.g., one marshmallow) in front of a young child with instructions that if the child waited until the experimenter returned (15 min), the child could have a large treat (e.g., two marshmallows). Alternatively, if the child rang a bell anytime during the interim, the experimenter would return immediately but the child could then have only the small treat. The amount of time that the child waited was significantly correlated a decade later with verbal and quantitative scholastic aptitude test (SAT) scores and parental ratings of the adolescent's ability to cope with frustration and stress and to pursue goals. This relationship was found only if the delay of gratification task was conducted with the small reward visible to the child (rather than being covered) and the child was not given any instructions about using distracting thoughts—in other words, conditions in which the child needed to use his or her own self-control strategies. Although Mischel and colleagues did not measure preventive behavior, such as studying, investing, receiving dental exams, or using seat belts, they did measure variables likely to be precursors of preventive behavior (ability to cope with frustration and pursue goals) or consequences of future-oriented behavior (SAT scores).

These findings suggest that a broader class of temporal attitudes might be important in driving preventive behaviors. That is, preventive behaviors may be less reflective of trade-offs between immediate and delayed outcomes than of other temporal attitudes. The relationships among time preference, other temporal attitudes, and preventive behavior is an interesting topic for future research.<sup>7</sup>

### *Applications of Time Preference Research*

Although one may well imagine that time preference research would have clear applications for changing behavior and encouraging preventive measures, the present research suggests that this may not be the case. Studies using hypothetical choices have found that discount rates tend to be lower (more value placed on future outcomes) for losses (rather than gains), small magnitude outcomes, long delays, and sequences (rather than individual outcomes). One may therefore conclude that by describing real-world preventive behaviors as choices involving sequences of small losses and long delays that one could decrease the discount rate and consequently promote preventive behavior. The lack of correspondence between real-world behavior and hypothetical choice

<sup>7</sup> A final example of a temporal attitude measure is the temporal orientation scale designed by Brown and Segal (1996), specifically for patients with hypertension. One subscale contains items that appear to capture the time preference concept. Sample items include "I see taking my blood pressure medication as an investment in my future health," and "I take my blood pressure medication mainly to have good health later on." This scale was included in Study 2 (data not shown). Although the scale was weakly related to the chest pain-time preference measure ( $r = .19$ ,  $N = 137$ ,  $p = .03$ ), it was not related to any of the adherence measures.

measures of time preference in the current studies, however, indicates that such manipulations might not encourage preventive behavior. It is more likely that preventive behavior can be influenced by manipulating the perceived costs and benefits or even the perceived delay to those costs and benefits rather than the psychological weight given to the delay.

Past time preference research indicates that decision makers do not possess a single discount rate; instead, discount rates vary with factors such as magnitude, delay, and gain or loss frame. This research is consistent with the current studies which indicate that decision makers do not have a consistent tendency toward a high or low discount rate that is expressed across situations. Rather, discount rates are very specific to contextual and response elicitation factors. It appears that within a given context and response format a decision maker uses a consistent process to resolve intertemporal trade-offs, but that decision process does not generalize to other contexts. Thus, a response to a hypothetical choice scenario about a short flu illness now or a longer flu illness later is not indicative of the response to an analogous hypothetical monetary scenario or of a real-world decision about whether to accept a vaccine now or risk a flu illness later.

Although the prospects may seem bleak for using time preference research as the basis for changing individual behavior and improving preventive health measures, it is possible that time preference research may fruitfully be applied in other areas. Another potential application area for time preference research is policy-level decisions meant to affect large groups of people. These decisions sometimes explicitly incorporate a discount rate. For example, public health officials must decide which health programs to fund, health insurers must decide which medical treatments to cover, and safety officials must decide which regulations to institute. Because many of these decisions involve consideration of both immediate and delayed consequences, they are sometimes based on analyses that incorporate a discount rate and therefore explicitly represent the intertemporal trade-off (e.g., Gold, Siegel, Russell, & Weinstein, 1996). An interesting topic for future research is whether findings from time preference research can or should influence public policy analyses.

### Conclusion

Although numerous everyday behaviors instantiate intertemporal trade-offs, the three such behaviors examined in the current studies were largely unrelated to time preferences measured with questionnaire scenarios. This finding indicates that decision makers do not have a single discount rate that they apply consistently across situations. Consequently, responses to hypothetical scenarios are not indicative of real-world behaviors.

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