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The surprisingly low motivational power of future rewards: Comparing conventional money-based measures of discounting with motivation-based measures

Jane E.J. Ebert *

Carlson School of Management, 321 19th Avenue South, University of Minnesota, Minneapolis, MN 55455, United States

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ABSTRACT

Temporal discount rates are often poor predictors of behaviors that we expect will be motivated by the future. The current research suggests this may be because conventional discounting measures are poor measures of the motivational value of future rewards. In six studies, I develop motivation-based measures of the present value (PV) of future rewards and compare the PVs obtained with those obtained using conventional money-based discounting measures. Conventional money-based PVs consistently overestimate motivation-based PVs and are discriminable from them. I explore explanations for this mismatch, including timing of effort exertion (Study 2) and loss aversion (Study 3), both features of the motivation-based measures. In Study 5, I use self-reports of valuation strategies and a time pressure manipulation to demonstrate that participants use different valuation strategies in the conventional money-based and the motivation-based measures that, in part, determine the difference in PVs obtained and the relatively low correspondence between them.

Introduction

A wide range of people's behaviors in the present are motivated by future concerns: employees work for future bonuses, students study to obtain a degree, people exercise and follow healthy diets for future health, and they save for retirement. People are often myopic in these behaviors: procrastinating in their work, failing to exercise, eating unhealthy foods, and saving insufficiently.

The value that people place on the future relative to the present is the focus of research on temporal discounting, a topic that is studied extensively in psychology and economics and in some applied fields, such as health behavior and financial investment. Temporal discount rates are broadly applied, often used in the construction of public policies that concern the future in domains such as finance, health, the environment, and urban planning, where they can have a large impact on whether or not a policy or project is implemented. While there is debate in these domains on the appropriate rate to use, individuals' discount rates are considered one important source (see Baron (2000) and Gyrd-Hansen and Søgaard (1998), for a related discussion; Schelling, 2000).

Much research in temporal discounting involves measuring these discounting rates for individuals, to examine how rates vary for different individuals (e.g., Green, Fry, & Myerson, 1994; Kirby, Petry, & Bickel, 1999), in different decision domains (e.g., Chapman, 1996), for different magnitudes of rewards (e.g., Kirby, 1997), for different delays into the future (e.g., Thaler, 1981), and to examine the relationship between individuals' discount rates and relevant real-life behaviors (e.g., Bickel, Odum, & Madden, 1999; Chapman & Coups, 1999).

The motivation for much of this research, either explicitly stated or implied, is to predict individuals' present behavior based on individuals' discount rates for behaviors that researchers expect will be influenced by future concerns. These behaviors, such as saving for retirement, exercising, or eating healthily are typically multi-determined, motivated by future concerns ("I would love to be in shape for the beach this summer and I want to be healthy when I am older"), present concerns ("I am too tired to go to the gym today"), and factors intrinsic to the present behavior ("but once I get running on that treadmill I usually enjoy it"). Researchers are interested in all of these influences on present behavior. However,

* Fax: +1 612 624 8804.
E-mail address: JEBERT@UMN.EDU

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I suggest that research on temporal discount rates has been focused on understanding the first of these, the motivational power of future concerns for present behavior, but that it commonly uses measures that do a poor job of assessing motivational power.

Good measures of constructs should satisfy a number of criteria. In particular they should be valid, reliable, and sensitive (Cook & Campbell, 1979; Cronbach & Meehl, 1955). I suggest that the methods conventionally used to measure individuals' discount rates mean that the discount rates obtained are likely to be inaccurate, and therefore invalid, measures of the motivational power of the future in the present. Specifically, I suspect that conventional discount rate measures are likely: (1) to overestimate the motivational power of the future for individuals and (2) to be discriminable from measures of the motivational power of the future, showing relatively low correlations with those measures. These are the hypotheses examined in the present research.

Conventional measures of discount rates and the motivational power of the future

While people's present behaviors are multiply determined (by both future and present concerns), when researchers use temporal discount rates to predict behavior, the discount rates are arguably intended to capture the power of future concerns to motivate individuals rather than the power of more immediate concerns. This is suggested by the type of research conducted on discount rates, which invariably takes an individual difference approach, focused on comparing discount rates across individuals who vary on characteristics such as gender, age, personality (Green et al., 1994; Ostszewski, 1996), and chronic lifestyle behaviors such as smoking (Bickel et al., 1999; Kirby et al., 1999), and on comparing discount rates in individuals across stable decision contexts or domains (Chapman & Elstein, 1995). This approach to discounting – looking at enduring individual differences – makes sense given that people's long-term desires are unlikely to change rapidly from moment to moment, but rather are enduring concerns that guide an individual's general behavioral tendencies. In contrast, more immediate concerns are vulnerable to short-lived influences, including changes in visceral effects such as hunger (Read & Van Leeuwen, 1998) or temporary decreases in self-control (Baumeister & Vohs, 2003; Read & Van Leeuwen, 1998). Therefore, in this research I focus on the motivational power of future rather than present concerns.

In this research, I also focus on a particular kind of present behavior: behavior that involves exertion of effort. Effort is considered a key marker of motivated, as opposed to passive, behavior (Martin & Tesser, 2009), and effort is important in many present behaviors that are motivated by future concerns. This includes behaviors that depend on self-control, which itself requires effort (Baumeister & Vohs, 2003). These might include behaviors such as exercising, giving up smoking, and controlling spending, failure on which can have substantial negative consequences for individuals and societies and all which have been examined alongside discounting measures (e.g., Bickel et al., 1999; Fuchs, 1982). Therefore, in this research I focus on the power of future concerns to motivate individuals to exert effort in their present behavior.

Researchers tend to measure discount rates using just a couple of established methods (Frederick, Loewenstein, & O'Donoghue, 2002). Most commonly they use direct valuation on a monetary scale: asking people to state the present value of a future reward (such as "What value *X* would make the two options in the following statement equally attractive to you: $*X* TODAY and $120 in 1 year?") or to make a series of choices between reward options (such as "Would you prefer to receive $100 today or $120 in 1 year?"). Discount rates are then calculated based on the present values (PVs) obtained.

But how well do discount rates measured in this way capture the motivation that the future will have on individuals' behavior in the present? That is, are they accurate measures of the motivational power of the future for present behavior? Existing research cannot answer this question.

First, while existing research finds that conventionally-measured discount rates are often poor predictors of present behaviors that researchers expect will be motivated by future concerns or benefits (Frederick, Loewenstein, & O'Donoghue, 2002), the reasons underlying this are unclear. Behaviors examined in existing research include health promotion behaviors, such as exercising, getting flu vaccinations, and having dental exams (Chapman & Coups, 1999; Chapman et al., 2001; Fuchs, 1982), harmful addictive behaviors, such as smoking, drinking heavily and using heroin (Bickel et al., 1999; Kirby et al., 1999), and financial decisions, such as incurring credit card debt (Fuchs, 1982). Results are mixed with some correspondence between discount rates and behavior in some but not all studies (see Frederick, Loewenstein, and O'Donoghue (2002), for a review). For example, smokers, heavy drinkers and heroin addicts typically have higher discount rates than non-smokers and those who have quit smoking (Vuchinich & Simpson, 1998), light drinkers (Kirby et al., 1999), and non-addicts (Kirby et al., 1999), respectively. However, correlations between discount rates and behaviors such as exercise, dental exams or getting flu vaccinations (Bickel et al., 1999; Chapman & Coups, 1999; Chapman et al., 2001) are very low.

There could be a number of reasons for these mixed results. In particular, many of these behaviors are in a different domain from the conventional measures used (e.g., health versus money) and so concern different future benefits. Other discounting research has shown that individuals use different discount rates for different domains (Chapman, 1996) and for different future benefits (Sultan & Winer, 1993). Therefore, any lack of correspondence between the behavior and discount rate may often simply be due to differences in discounting across domains or type of benefit, and cannot answer the question of whether conventional discounting measures are accurate measures of the motivational power of the future in the present.

However, even studies that examine behaviors in the money domain, which would allow comparison with discount rates obtained by conventional discounting measures in the money domain, cannot adequately answer this question. Some studies appear, on first sight, especially promising in this respect, in that they infer individual discount rates directly from behavior, potentially providing a direct assessment of the motivational power of the future for present behavior for comparison with conventionally obtained discount rates. However, these studies have examined relatively complex behaviors that seem to be determined largely by factors other than the motivational power of the future.

For example, two studies of this type, Gately (1980) and Hausman (1979), infer individuals' discount rates based on the purchase of electrical durables, such as air conditioners and refrigerators. Such purchase decisions involve an implicit tradeoff between monetary benefits in the present and future as they involve a tradeoff of initial purchase price and electrical efficiency over time (greater initial purchase price corresponds to greater efficiency). However, in these studies, people's decisions appeared to reflect (or were largely determined by) considerations other than the motivational power of the future, such as current financial constraints (as in Hausman, 1979) or ignorance of future operating costs (as suggested by Gately, 1980). Therefore, existing research cannot tell us whether conventional measures of discounting provide accurate measures of the motivational power of the future for present behavior.

Furthermore, there is reason to believe that conventional discounting measures may in fact be inaccurate measures of the motivational power of the future for present behavior. People often use

their affective responses as proxies for value, and assessment of the motivational power of a reward is likely to be relatively affect-based, given the close functional association between affect and motivation (see Pham, 2007 for a recent review of related literature). But past research finds that monetary valuations and affect-based valuations often show dissociation, for example, due to consideration of different factors, such as the consideration of transaction costs for monetary valuations but not for affect-based valuations (Amir, Ariely, & Carmon, 2008), or due to the use of different psychological processes for monetary and affect-based valuations, such as valuation by calculation versus valuation by feeling, respectively (Hsee & Rottenstreich, 2004). Similarly, people may rely on different psychological processes in money- versus motivation-based valuations of future rewards. Some research suggests that people may use an anchor-and-adjustment heuristic when valuing future rewards (Ebert, 2001), anchoring on the monetary value of a reward before adjusting that value for the delay until receipt of the reward. If people rely on an anchor-and-adjustment heuristic for conventional money-based valuations of a future reward, but rely on their feelings for motivation-based valuations of a future reward, they are likely to show dissociations between these two types of valuation.

Furthermore, people's valuations for future rewards on a motivation-based measure are likely to be lower than their conventional money-based valuations for two reasons. First, future events are perceived as qualitatively different from present events: future events appear more abstract (Liberman & Trope, 1998), are less emotionally involving (Ekman & Bratfisch, 1965; Kassam, Gilbert, Boston, & Wilson, 2008) and less arousing (Mischel, Ayduk, & Mendoza-Denton, 2003) than present events. If an affect-based approach to valuation better reflects the low emotional involvement and arousal characteristic of future rewards relative to present rewards, this could result in lower valuations of future rewards for a motivation-based measure. Second, if people rely more on an anchor-and-adjustment heuristic for conventional money-based valuations of future rewards their valuations of future rewards are likely to be relatively higher compared to a motivation-based measure, because such adjustment tends to be insufficient (Gilbert, 2002; Tversky & Kahneman, 1974).

This discussion leads to the primary hypotheses examined in this research:

H1. Conventional money-based measures of discounting are likely to result in higher PVs for future rewards than will motivation-based measures of discounting.

H2. PVs for future rewards that are obtained from conventional money-based measures of discounting are likely to be discriminant from motivation-based measures, showing relatively low correlations with them.

To examine these hypotheses, several methods are developed to measure the motivational value of future monetary rewards for behavior (and estimated behavior) in the present – i.e., the *motivation-based* PV of a future reward. Motivation-based PVs are then compared with PVs obtained using conventional (i.e., *money-based*) measures of discounting.

Motivation-based measures of PV

Several measures were developed to provide motivation-based measures of PV. These measures were carefully constructed to include important features that would enable a direct and meaningful comparison with the PVs of future rewards obtained using conventional money-based measures of discounting. First, because discount rates differ for different types and magnitudes of rewards, the future reward used in the motivation-based measure must be the same as whatever is used in the conventional money-based measure. For example, the motivation-based measure developed for use in Studies 1a and 1b used a real monetary reward that was also used in one of the conventional money-based measures in those studies.

Second, the motivation-based measure must use a task on which performance (via effort) shows a strong correspondence with monetary reward. This is not a trivial requirement. According to reviews in the financial incentive literature (Camerer & Hogarth, 1999; Jenkins, Mitra, Gupta, & Shaw, 1998), some tasks show a poor correspondence between financial incentive and performance. For example, for tasks such as problem-solving, performance is largely determined by skill so effort exerted in response to the incentive can have little effect on performance. Similarly, tasks may be intrinsically rewarding for participants again resulting in less correspondence between extrinsic monetary incentives and performance on the task. However, some tasks do show a strong correspondence between incentive and performance (via effort): those that are low skill and that provide little or no intrinsic reward. Such incentive-sensitive tasks include vigilance or detection tasks (such as spotting typing errors), pain endurance, and mundane clerical or production tasks (such as assembling erector sets or coding items). The motivation-based measures developed here used a detection task (in Studies 1–4 participants counted instances of a series of four letters – "lihk" – in a long paragraph of syntax) or an endurance task (in Study 5 participants listened to an unpleasant noise). The dependent variable on the task was a measure of effort: either actual time spent on the task (Studies 1a and 1b) or estimated time to spend on the task (Studies 2–5) for different monetary rewards. As shown in each of the studies presented, variation on this dependent variable showed a close correspondence with variation in monetary reward.

Third, the dependent variable used for the motivation-based PV measures, i.e., time (or estimated time) spent was deliberately chosen to be an indicator of *effort*. Effort is considered to be a key marker that helps to distinguish motivated behavior from other types of behavior that are passive or not motivated (Martin & Tesser, 2009). There is a general tendency for effort to increase with motivation (Wright & Brehm, 1989), so that a measure of effort serves as a relatively direct measure of motivation.

Fourth, on conventional money-based measures of PV participants identify the value of present reward for which they are indifferent between receiving that reward and a specified future reward, i.e., the future reward is essentially measured on a scale of "equivalent present reward". The motivation-based measure was developed similarly to identify the present reward that was equivalent in value, and more specifically equivalent on *motivational value*, to the future reward. Each valuation measure used future monetary rewards and a range of present monetary rewards to allow calibration of present effort for the *future* reward against present effort for *present* rewards, to provide the motivation-based PV of the future monetary reward.

Fifth, given that individuals can vary considerably on the discount rates they use, to ensure sensitivity in the comparison of the motivation-based and conventional money-based measures, the same individuals completed both measures.

Finally, as mentioned earlier, there are two principal methods used in conventional measures of discounting: a choice method (involving a series of choices between reward options) or a matching method (where participants state the value equivalent to a reward). The conventional money-based measure used here for comparison with the motivation-based measures used a matching method where participants state the value in the present (i.e., the PV) that is equivalent to a future reward, rather than, say, stating the value in the future that is equivalent to a present reward. This method was chosen for three reasons: (1) a choice method would

be hard to use with the motivation-based measures developed here because of considerable fatigue or practice effects that are likely to occur from one choice to another; (2) this is by far the most commonly used matching method (Frederick, Loewenstein, & O'Donoghue, 2002); and (3) this method exactly corresponds to the valuation measure for the motivation-based measures, where participants indicate value in the present by their effort in the present for a future reward.

In summary, these six features enable a direct and meaningful comparison of motivation-based PV with the conventionally obtained money-based PV for the same future reward.

The current research

There were two goals in this research. The first (addressing Hypotheses 1 and 2) was to test whether conventional money-based discounting measures are accurate measures of the motivational power of the future for present behavior, by constructing motivation-based measures of PV, and comparing the PVs obtained for future rewards with the PVs obtained from conventional money-based measures for the same future rewards. In each of six studies, I find that conventional money-based measures considerably overestimate the motivational value of future monetary rewards or, put another way, that future monetary rewards show a surprisingly low motivational power for present behavior. This result is obtained using different measures of motivation-based PV, that is, actual effort (Study 1a and 1b) and estimated effort (Studies 2–4) on a detection task, and estimated effort on an endurance task (Study 5); it is obtained using different response options when measuring conventional money-based PV, that is, stating equivalent-value (Studies 1a, 1b and 2), stating willingness to invest (Study 3), and indicating value on a visual-analogue scale both with and without markings (Studies 3–5); and it is obtained when presentation of rewards and valuation response modes are identical for money- and motivation-based measures (Studies 3–5).

The second goal was to explore potential explanations for this persistent inconsistency between money- and motivation-based PV. In four studies, I examine the effect on PV: (1) of the timing of exertion of effort in the motivation-based measure, (Study 2); (2) of adding loss aversion to the conventional money-based measure by using an invest version of this measure (Study 3); and (3) of the valuation strategy used by participants in the money- and motivation-based measures (Study 5). The results of these studies suggest that the persistent overestimation by conventional money-based measures of PV of the motivational value of future rewards is not caused by the proximity of exertion of effort in the motivation-based measure or by a lack of loss aversion in conventional money-based measures. This overestimation is, at least in part, accounted for by the valuation strategy typically used for the conventional money-based versus the motivation-based measures of PV in these studies. For the conventional money-based measures many people rely on an anchoring-and-adjustment valuation strategy, while for the motivation-based measures they more commonly apply a valuation strategy based on affect. This latter strategy, where feelings associated with present effort on a task are directly compared with feelings associated with future rewards, results in a lower PV for future rewards. The results of these six studies suggest that future rewards have surprisingly little motivational power, at least compared to what conventional money-based discounting measures would lead us to expect.

Studies 1a and 1b

In Studies 1a and 1b, all participants completed conventional money-based measures of PV for future rewards and a motivation-based measure of PV. For the motivation-based measure, participants worked on a detection task for a present or future reward determined by experimental condition. The relationship between present rewards and effort on the task (time worked) was modeled using least-squares regression, and the model was then used to estimate participants' PVs for the future rewards based on time worked for the future rewards. These motivation-based PVs were compared with PVs obtained from conventional money-based measures of present value.

Study 1b is a replication of Study 1a, with minor changes in procedure. Given the similarity between the two studies, they are presented together.

Method

Participants and design

Study 1a. Student participants (N = 171, 92 female, 79 male; mean age 24.3 years, SD = 7.8 years) at an east coast private university were recruited using posters on campus. They completed the study in groups of 2–12 and received $12 plus any reward they won.

Participants were randomly assigned to one of five *reward* conditions: 3 present rewards ($2 today, $10 today, $25 today) and 2 future rewards ($25 in 3 months, or $25 in 12 months), with proportionally more participants in the future reward conditions to increase power in some analyses (*n*s were 25, 24, 24, 49, and 49, respectively for the five reward conditions). Each participant completed a motivation-based measure of PV and conventional money-based measures of PV. The data from participants in the three present reward conditions were used to calculate PVs in the motivation-based measure. The PVs obtained (i.e., motivation-based PV and conventional money-based PV) were then compared for each participant in the two future reward conditions.

Study 1b. Participants were students at a mid-west public university (N = 167, 103 female, 64 male; mean age 20.6 years, SD = 3.0 years). Payment was either $8 or course credit, plus any bonus reward payment they earned. The randomly assigned reward conditions for the experimental task were three present reward conditions ($1 today, $10 today, $25 today; *n*s were 31, 31, 35, respectively) and only one future reward condition ($25 in 12 months; n = 70). The procedure was identical and the materials were very similar to Study 1a. Differences are mentioned in the relevant parts of the "Procedure and materials" section.

Procedure and materials

Participants were first emailed with a conventional money-based measure of PV to complete and asked to attend a lab-based study for 1 hour several days later. Once at the lab they were told: they would be completing a number of tasks of total duration of 35 min for a payment of $12, with the possibility of bonus reward payments for each of the first two tasks. There were seven tasks: two "syntax perception" tasks, then two questionnaires (a manipulation check, a second conventional money-based measure of PV), and finally three (unrelated) tasks. Participants were then debriefed and paid, including any bonus present reward payments. For any bonus future reward payments, participants addressed a stamped envelope for payment to be sent later.

Motivation-based PV

This was calculated based on the two syntax tasks completed by each participant. In each of the syntax tasks participants were asked to count the instances of a particular series of four letters in a passage of syntax. For example, counting the instances of the series "lihk" in the passage below::

hkidlihkkislhkidslkslkdslslihklihkslklihkhkidhkidhkidhkidhkids lkdslslihkslkslklihkslkslklihkhkiddslslihkhkidslklihkslkhkidlihkl ihklihkdslshkiddslshkidhkidkislhkidhkidkisldslskisllihklihkslkd slslihklihkslkkislhkidslkhkiddslsdslskislhkidhkiddslslihkkislkisl hkidlihkkislhkidslkslkdslslihklihkslklihkhkidhkidhkidhkidhkids lkdslslihkslkslklihkslkslklihkhkiddslslihkhkidslklihkslkhkidlihkl ihklihkdslshkiddslshkidhkidkislhkidhkidkisldslskisllihklihkslkd slslihklihkslkkislhkidslkhkiddslsdslskislhkidhkiddslslihkkislkisl hkidlihkkislhkidslkslkdslslihklihkslklihkhkidhkidhkidhkidhkids lkdslslihkslkslklihkslkslklihkhkiddslslihkhkidslklihkslkhkidlihkl ihklihkdslshkiddslshkidhkidkislhkidhkidkisldslskisllihklihkslkd slslihklihkslkkislhkidslkhkiddslsdslskislhkidhkiddslslihkkislkisl hkidlihkkislhkidslkslkdslslihklihkslklihkhkidhkidhkidhkidhkids lkdslslihkslkslklihkslkslklihkhkiddslslihkhkidslklihkslkhkidlihkl.

For each of the two tasks, participants were also told: (1) they would receive a bonus payment for a correct count, (2) they could spend as much or as little time on the task as they wished, (3) that any time spent on each syntax task would be in addition to the expected study duration of 35 min. Participants arrived having allowed at least 1 hour for the study, which meant that all participants had at least 25 min available to them to spend trying to earn the bonus reward payments on these two tasks. The first syntax task served as the *baseline* task, to help control for individual differences in time worked on the syntax tasks. It had the same reward (i.e., potential bonus) for all participants: $2 to be paid "at the end of the session TODAY". For the second (*experimental*) syntax task the reward size and delay varied according to participants' randomly assigned *reward* condition: $2 today, $10 today, $25 today, $25 in 3 months, or $25 in 12 months. Present rewards would be given "at the end of the session TODAY" while rewards available in 3 and 12 months would be mailed after the stated delay, as "some of our funding comes from sources not currently accessible". For Study 1b, the reward for the baseline task was $1 and the randomly assigned reward conditions for the experimental task were: $1 today, $10 today, $25 today, and $25 in 12 months.

The main dependent variable was the time participants worked on the experimental syntax task. The care taken by participants on the task was also assessed using three variables: participants recorded their count (to provide a measure of accuracy), they estimated the number of times they went through the passage when counting, and they rated their care in counting on a 10-point scale, 1 (*Not at all careful*) to 10 (*Extremely careful*).

Conventional money-based PV

There were two measures. In the "between" measure (completed over e-mail), participants specified the exact value that would make two prize options in a statement equally attractive: $____ TODAY and $25 in 3 months" (or "in 12 months" depending on their randomly assigned reward condition). Participants in the present reward conditions also completed a valuation, randomly assigned. This measure used real monetary rewards (as did the motivation-based measure). To help ensure honest and accurate answers from participants they were told that we had randomly selected a dollar amount $X which was less than $25, and if the value they stated was lower than $X the prize would be available on the day they came in, while if the value was higher than $X the prize would be $25 available 3 months (12 months) later (see Becker, DeGroot, & Marshak, 1964, who developed this approach). In the "within" measure, participants valued a series of hypothetical future rewards that varied in delay and value (i.e., value and delay are varied *within*-subjects). Nine valuation statements (like those in the between measure) were used crossing each of three delays (2 weeks, 3 months, 12 months) with three values ($10, $25, $35) presented in one of two randomly assigned orders (increasing or decreasing value and delay). Matching PV for a series of future rewards, as on the within measure, is more typical of matching based conventional discount measures, while matching PV for just one future reward, as on the between measure, more closely emulates the structure of the motivation-based measure in this study.

For Study 1b, the measures used were the same as for Study 1a, except that: the between measure only assessed the value of one prize option ($25 in 12 months); and for the within measure, participants provided eight valuations of hypothetical rewards, with six probabilistic and two delayed rewards ($25 available after 3 or 12 months).

Manipulation check

Following the two syntax tasks participants were asked to recall the value of each reward and when it was available. They rated their confidence in the count estimates they provided using a 10-point scale, 1 (*Certain my estimate was incorrect*) to 10 (*Certain my estimate was correct*), and provided demographic information. In Study 1b, participants also indicated the likelihood that they would receive the reward.

Results

Motivation-based PV

Time worked. A square root transform was used for the times worked on each of the syntax tasks to improve normality, and outliers (>2.5 *SD*s from the condition mean) were removed (5 in Study 1a, 7 in Study 1b). For each of Studies 1a and 1b, an ANOVA on these (transformed) time scores[1] for the baseline task first confirmed that there were no significant differences between reward conditions ($F < 1$). For Study 1a, a 2 Task (baseline, experimental) × 5 Reward ($2 today, $10 today, $25 today, $25 in 3 months, $25 in 12 months) ANOVA on the time scores revealed a main effect of task, $F(1,161) = 15.95$, $p < .001$, $\eta = .30$, and a Task × Reward interaction, $F(4,161) = 11.02$, $p < .001$, $\eta = .46$, only. As one would expect, people worked longer on those experimental tasks with a larger reward (see Fig. 1). *t*-Tests on (transformed) time scores revealed that time worked for the $25 in 3 months reward was similar to that for the $10 today reward ($M_{\$25\ \text{in 3 months}} = 8.37$ min, $M_{\$10\ \text{today}} = 8.82$ min, $p = .31$), but differed significantly from the $2 and $25 today reward conditions ($M_{\$2\ \text{today}} = 6.11$ min, $M_{\$25\ \text{today}} = 10.97$ min, $ps < .03$), while time worked for the $25 in 12 months reward was similar to that for the $2 today reward ($M_{\$25\ \text{in 12 months}} = 6.09$ min, $p = .67$), but differed significantly from the $10 and $25 today reward conditions ($ps < .001$).

Study 1b showed a similar pattern of results (see Fig. 1). A 2 Task (baseline, experimental) × 4 Reward ($1 today, $10 today, $25 today, $25 in 12 months) ANOVA on the (transformed) time scores revealed main effects of task, $F(1,156) = 51.49$, $p < .001$, $\eta = .50$, and reward, $F(3,156) = 2.61$, $p = .05$, $\eta = .22$, and a Task × Reward interaction, $F(3,156) = 6.14$, $p < .001$, $\eta = .33$. Here, the time worked for the $25 in 12 months reward was similar to that for the $10 today reward ($M_{\$25\ \text{in 12 months}} = 6.55$ min, $M_{\$10\ \text{today}} = 6.19$ min, $p = .73$) and differed from the $1 and $25 today reward conditions ($M_{\$1\ \text{today}} = 4.82$ min, $M_{\$25\ \text{today}} = 8.99$ min, $ps < .06$).

Care taken. Standardized scores of the three variables[2] relevant to participants' care on the task (i.e.: count error, recorded as the absolute difference between participants' count estimate and the correct count; number of times through passage when counting; and care in

[1] A number of participants gave incorrect answers on some manipulation checks. The analyses were also conducted removing these participants with no change in the pattern of the results.

[2] Each variable was first transformed to improve its normality.

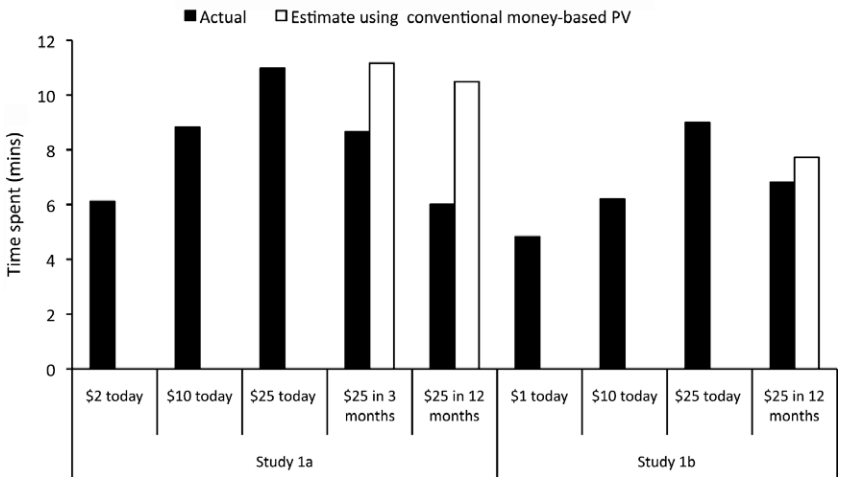

Fig. 1. Means of actual time spent on syntax task versus mean times estimated using conventional money-based measures for different rewards in Studies 1a and 1b.

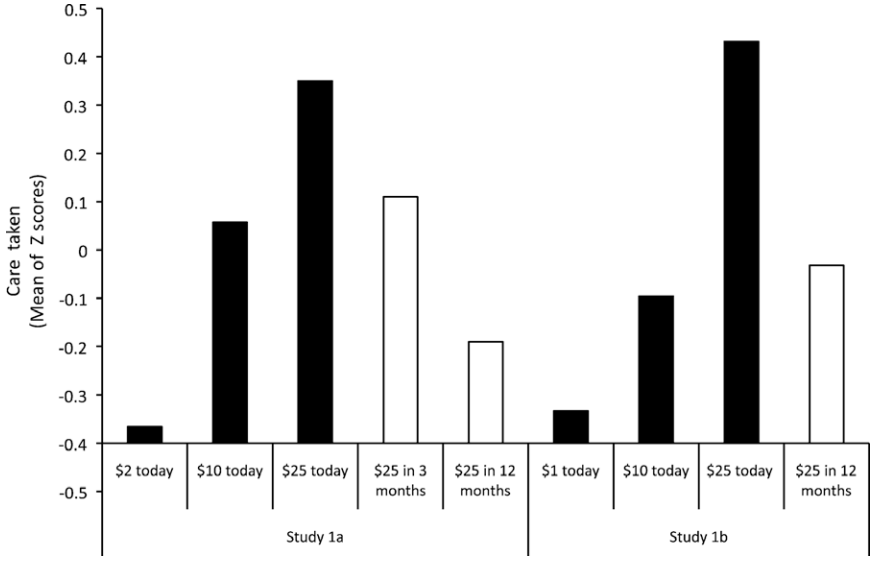

Fig. 2. Means of care taken summary variable for different rewards in Studies 1a and 1b.

counting) were combined to form a summary variable of care taken (reverse-scoring the standardized scores for the count error variable) for the baseline task and for the experimental task. The care that participants took on the task corresponded closely to the time they spent on it. First, correlations by reward condition between care taken and time worked were high and significant (Study 1a: *r*s from .82 to .94, all *p*s < .001; Study 1b: *r*s from .42 to .78, all *p*s < .01). Second, Task × Reward ANOVAs on care taken for each study revealed similar results to those for time taken. For both studies there was a Task × Reward interaction (Study 1a: $F(4,161) = 6.68$, $p < .001$, $\eta = .38$; Study 1b: $F(3,156) = 6.22$, $p < .001$, $\eta = .33$) and focused tests comparing different reward conditions revealed a very similar pattern of results to the time worked variable (see Fig. 2).

Conventional money-based PV[3]

Additional participants were excluded from all analyses involving the conventional PVs either: if they gave PVs (far) greater than $25 when valuing $25 in 3 or in 12 months indicating either negative discounting[4] or a misunderstanding of the question (2 in Study 1a, 6 in Study 1b); or if they were missing data for these measures (7 in Study 1a, 6 in Study 1b). The between and within[5] conventional PV measures obtained very similar PVs (for Study 1a: $25 in 3 months, $M_{between} = \$18.67$, $M_{within} = \$18.00$; $25 in 12 months, $M_{between} = \$16.45$, $M_{within} = \$16.20$; no effect of within versus between measure on a repeated measures ANOVA, $p = .34$; for Study 1b: $25 in 12 months, $M_{within} = \$14.22$; $M_{between} = \$15.32$; for paired *t*-tests, $p = .13$) and the correlation between them was high (Study

[3] Results provided are for participants in the future bonus conditions only, for consistency with the results comparing participants on conventional money-based and motivation-based PVs. However, results for conventional money-based PVs for all participants were extremely similar.

[4] Results are reported excluding these participants for two reasons. First, exclusion of negative discounters makes these results more comparable to most other discounting studies, which commonly employ methods that require positive discounting or whose response scales exclude options that would indicate negative discounting (e.g., Alessi & Petry, 2003; Chapman & Coups, 1999; Coller & Williams, 1999; Green, Myerson, & McFadden, 1997). Second, excluding negative discounters decreases conventional money-based PV, and so ensures a conservative comparison of conventional money-based and motivation-based PV when conventional money-based PV is higher, as here. Including the negative discounters in the analyses did not alter the results or conclusions in this study or in the subsequent studies.

[5] There were no effects of presentation order for the within discounting measure.

1a: $r_{\$25 \text{ in } 3 \text{ months}} = .81$, $r_{\$25 \text{ in } 12 \text{ months}} = .72$; Study 1b: $r_{\$25 \text{ in } 12 \text{ months}} = .78$).

Comparing money- and motivation-based PV

The results for conventional money-based PV (above) and motivation-based PV (Fig. 1) suggest that the present motivation that people say is equivalent to a future reward on a conventional money-based measure of discounting is higher than the present reward that has the same motivational value for those people. That is, the motivation-based PV for the future rewards is considerably less than their conventional money-based PV.

To test the statistical significance of this difference, the following procedure was used. The relationship between present reward (i.e., the today rewards) and time worked on the task was modeled using least-squares regression. The relationship between (log) present reward and (transformed) time worked was reasonably linear. This model allows easy calibration of time worked on the task against the equivalent present reward, so that the conventional money-based and the motivation-based PV can be represented on the same scale, allowing a statistical test of the difference between them. For all participants in the present reward conditions, the (transformed) time scores for the experimental task were regressed against the (transformed) time scores for the baseline task[6] and (the log of) the reward (i.e., in Study 1a: ln $2, ln $10, or ln $25; regression $R^2 = .473$, $p < .001$; in Study 1b: ln $1, ln $10, or ln $25; regression $R^2 = .455$, $p < .001$[7]). Both variables were significant predictors of the time participants spent on the experimental task: participants who worked longer on the baseline task also worked longer on the experimental task (Study 1a: $\beta = 0.611$, $p < .001$; Study 1b: $\beta = 0.513$, $p < .001$) and people worked longer for larger rewards (Study 1a: $\beta = 0.401$, $p < .001$; Study 1b: $\beta = 0.304$, $p < .001$). For participants in the future reward conditions, the unstandardized coefficients from this regression were combined with their (transformed) time scores for the baseline task and (the log of) the conventional money-based PVs they gave for their reward (i.e., for $25 in 3 months or $25 in 12 months as appropriate) to estimate the times that these participants *should* have worked on the experimental syntax task given their conventional money-based PVs. (Separate estimates were calculated for each of the within and between conventional PV measures.) For each of the future reward conditions for each of the within and between conventional measures, paired *t*-tests showed that the time estimate corresponding to the conventional money-based PV was significantly greater than the actual time participants spent on the task for each future reward condition (see Fig. 1), and when calculated using either the within or between conventional measures (Study 1a: $ts > 3.41$, $ps < .001$, $rs > .46$; Study 1b: $ts > 2.90$, $ps < .005$, $rs > .37$). In other words, conventional money-based PV was significantly greater than motivation-based PV for the same participants for the future rewards (Hypothesis 1).

The conventional money-based and the motivation-based PVs were also relatively independent across participants (Hypothesis 2): correlations between the transformed time worked variable and conventional money-based PVs were generally very low or close to zero (Study 1a: for the between measure, $r_{\$25 \text{ in } 3 \text{ months}} = .06$, $r_{\$25 \text{ in } 12 \text{ months}} = .08$; within, $r_{\$25 \text{ in } 3 \text{ months}} = .01$, $r_{\$25 \text{ in } 12 \text{ months}} = .22$; all $ps < .16$; Study 1b: between, $r_{\$25 \text{ in } 12 \text{ months}} = -.01$; within, $r_{\$25 \text{ in } 12 \text{ months}} = .004$; $ps < .93$).

Additional manipulation check analysis

One problem commonly recognized in temporal discounting research is that participants may treat future rewards as less certain than immediate rewards, for example if they do not trust the experimenter to deliver the future reward, or if participants suspect they will forget to claim it. In the current research this did not seem to be a problem. Examination of participants' estimates of the likelihood that they would receive the reward for the baseline and experiment tasks (asked in Study 1b only) revealed the same pattern of responses whether the reward was available today or in the future.

Discussion

Studies 1a and 1b found that the motivation-based PVs for two future rewards were lower than the conventionally measured PVs for the same rewards for the same participants (Hypothesis 1). That is, the present reward that participants *said* was equivalent for them to a future reward was greater than the present reward that was *actually* equivalent to that future reward when they exerted effort for it. The two conventional money-based PV measures gave very similar results, even though one used real rewards (as did the motivation-based measure) and the other used hypothetical rewards. Participants showed this inconsistency or difference in PV twice during both studies: moving from the first conventional money-based measure, then to the motivation-based measure, then to the second conventional measure.

This result does not simply imply that the monetary value and motivational value of a monetary reward are different. What is especially interesting here is that that even when motivational value and monetary value are matched using present monetary rewards, they are different for future monetary rewards. That is, the *relative value* (the PV) is different for the two measures. Something about valuing *future* rewards using these two measures results in a difference between the motivational value and monetary value of those future rewards, even when responses on the two measures are matched for present reward. Furthermore, the correspondence between the two measures is very low (supporting Hypothesis 2). So the conventional money-based PV measure appears to overestimate the motivational value of a future reward for present behavior and shows a low correspondence with its motivational value. This was the case in two studies, conducted in different student populations.

In the following four studies I replicate these results to provide additional support for Hypotheses 1 and 2), and I attempt to understand the observed difference in PV between the conventional money-based and the motivation-based measures in Studies 1a and 1b. These two types of measure differ in many respects. First, the measures differ in the presentation of and the mode of response to the stimuli in the studies (i.e., to the rewards). Therefore, a primary objective of the following studies was to ensure the difference in PV between money- and motivation-based measures would replicate when differences in presentation and response mode were removed. Second, the measures differ in psychologically important ways that may highlight qualitative differences between present and future rewards or that may change the process by which participants value rewards for each measure, resulting in a difference in PV. Therefore, a second objective on the following studies was to test several explanations of the difference between the PVs obtained using conventional money-based versus using motivation-based measures.

In the motivation-based measure in Studies 1a and 1b, the rewards were varied between-subjects. This was deliberate: (1) to assess the "true" motivational value of a future reward, by removing the opportunity for participants to ensure they were consistent in the value they assigned for future relative to present rewards across the conventional money-based and the motivation-based measures and (2) to avoid fatigue effects from participants working for multiple rewards. Replicating this difference between PVs in

[6] The inclusion of this variable in the regression was important for reducing noise due to individual variance in time spent on the syntax tasks.

[7] The linear regression also included a dummy variable representing whether participants received payment or course credit.

circumstances where participants are better able to impose consistency (if they want to), would be compelling evidence for a difference in PV between these measures that participants do not believe needs correction. Therefore, in all the remaining studies, the rewards are manipulated *within*-subjects, where participants can indicate the value of both present and future rewards. Fatigue effects are avoided in the new within-subjects design by changing the motivation-based measure: in Studies 2–4 all participants worked on the syntax task for a fixed time before stating how long they would work on the task for each of a series of (hypothetical) monetary rewards, including both present and future rewards; in Study 5 a new task is used in the motivation-based measure, where again monetary reward is varied within-subjects. The approach is still focused on measuring exerted effort, but now participants estimate rather than demonstrate their effort exertion.

A related difference between measures in presentation is that the PVs of present and future rewards are assessed separately in the motivation-based measure, while present and future rewards are directly compared to each other in the conventional money-based measure. This separation means each reward should be assessed more independently (Hsee, 1999) such that the motivation-based measure better captures any qualitative difference between present and future rewards (Ekman & Bratfisch, 1965; Kassam et al., 2008; Liberman & Trope, 1998; Mischel et al., 2003), potentially explaining the smaller PV obtained with the motivation-based measure relative to the conventional money-based measures. Therefore Studies 3–5 use a version of the conventional money-based PV measure that allows separate assessment of present and future rewards, just as on the motivation-based measure, with identical calculation of the PVs for the money- and motivation-based measures using these separate assessments.

The money- and motivation-based measures in Studies 1a and 1b also differ on response mode: explicitly stating a dollar value for the conventional money-based measure versus exerting effort (measured as time worked on the syntax task) for the motivation-based measure. Therefore, Studies 3–5 use versions of both the money- and motivation-based measures that rely on the same response mode: using a computer mouse to click on a visual-analogue scale to indicate dollar value and estimated effort exertion, respectively.

In addition to attempting to replicate the results of Studies 1a and 1b after removing presentation and response mode differences between the money- and motivation-based measures, the remaining studies test several possible explanations of the difference in PVs between measures. To account for the difference in PVs, any characteristic that differs for the money- and motivation-based measures needs to affect valuation of present and future rewards differently. If the characteristic affects valuation of both present and future rewards in a similar way or to a similar extent, it is unlikely to explain the difference in PV seen across measures, as PV is a *relative* measure of value (of future relative to present reward).

A defining characteristic of the motivation-based measure is that it involves exertion of effort in the present for a future reward. It could be that the proximity of effort exertion is responsible for the difference between the PVs, if this characteristic affects participants' behavior differently for present versus future rewards. For example, if a direct comparison of a reward with exertion of effort highlights any qualitative difference between present and future rewards such that a future reward seems particularly weakly motivating relative to a present reward, this could result in lower PVs for future rewards on the motivation-based measure. This explanation is examined in Study 2, where the effort exerted in the present is manipulated to occur at about the same time or separated in time from valuation on the motivation-based measure.

A second (related) argument concerns the fact that exertion of effort in the present is akin to a loss for the participant in the motivation-based measure. Past research finds that people expect losses to have a greater impact than equivalent gains (Kahneman, 2003; Kerner, Driver-Linn, Wilson, & Gilbert, 2006) resulting in loss aversion. In contrast to the motivation-based measure, the conventional money-based measure involves no loss: participants must instead identify a present reward value that is equivalent to a future reward. If this characteristic of the conventional money-based measure affects participants' valuations for present versus future rewards differently, for example if estimating an equivalent loss for present and future rewards better captures any qualitative difference between them, this could lead to a larger difference in valuation for present and future rewards, and so explain the difference in PV between the conventional money-based and the motivation-based measures. This explanation is examined in Study 3, which uses two versions of the money-based measure – an "invest" version in addition to the "equivalent-value" version – to examine the effect of loss aversion on the relative valuation of present versus future rewards.

Another argument for why the motivation-based measure may better capture any qualitative difference between present and future rewards concerns the valuation strategy used by participants on each measure. As discussed earlier, some research suggests that people may use an anchor-and-adjustment heuristic when valuing future rewards (Ebert, 2001). In two studies using valuation scales, Ebert (2001) showed that participants provided higher present valuations for future rewards (e.g., receiving a TV in a year) when their cognitive resources were constrained, while their present valuations for immediate rewards (receiving a TV today) were unaffected, suggesting they anchored on an initial valuation of the reward before adjusting that value down to take into account the delay of the reward. In contrast, the motivation-based measure may rely on a more affective approach, e.g., a person might instead simply assess his feelings about receiving the future reward, resulting in different valuations of future rewards for the conventional money-based and the motivation-bases measures. If an affective approach to valuation better captures any qualitative difference between present and future rewards, such as the lower emotional involvement (Ekman & Bratfisch, 1965; Kassam et al., 2008) and arousal (Mischel et al., 2003) of future rewards, this could lead to lower valuations for future rewards and a larger difference in valuation for present and future rewards for the motivation-based measure, and so explain the difference in PV between the conventional money-based and the motivation-based measures.

Alternatively (or in addition) if people rely more on an anchor-and-adjustment heuristic for the conventional money-based measure relative to the motivation-based measure, their valuations of future rewards may be relatively higher for the conventional money-based measure because such adjustment tends to be insufficient (Gilbert, 2002; Tversky & Kahneman, 1974). These explanations are examined in Study 5, in which I measure and manipulate participants' use of different valuation strategies in money- and motivation-based measures to examine their effect on participants' PVs for future rewards for both measures.

Finally, in Studies 2–5, I bolster support for Hypotheses 1 and 2 by developing additional money- and motivation-based measures, first, to examine whether the difference between money- and motivation-based PVs generalizes to these new measures (relevant to Hypothesis 1), and, second, to examine the convergent and discriminant validity for the money- and motivation-based measures of PV (relevant to Hypothesis 2) using multiple methods for each type of measure (Campbell & Fiske, 1959). Finally, in Studies 4 and 5, I include other measures intended to assess individuals' inter temporal preference, to examine further the construct validity (Campbell & Fiske, 1959) of the money- and motivation-based measures of PV.

Study 2

This study examines the effect of the timing of effort exertion on valuation by comparing two conditions: one where exertion of effort and valuation occur at about the *same time*, and another where exertion of effort and valuation are *separated in time*. If the difference obtained between the conventional money-based and the motivation-based PVs is caused by the proximity of effort exertion in the motivation-based measure, the motivation-based PV should increase to become closer to the conventional money-based PV when exertion of effort and valuation are separated in time. This study also uses a within-subjects manipulation of reward for the motivation-based measure.

Method

Participants and design

Participants were 137 students at a mid-west public university (71 female, 65 male, 1 did not specify gender; mean age 21.0 years, *SD* = 2.1 years) from three classes, who completed the study in class for course credit.[8]

Participants were randomly assigned to one of two *effort timing* conditions (*same-time* and *separated-in-time*, *n*s were 68 and 69, respectively). Each participant completed a money- and motivation-based measure of PV for two future monetary rewards, with the order of completion of the measures counterbalanced across participants. For the motivation-based measure, each participant also completed valuations of three present monetary rewards, used to calculate the PVs for the future monetary rewards in the motivation-based measure.

Procedure and materials

The experimenter paced all participants through four questionnaires, over half an hour, in one of two orders: *money-based first*: (1) money-based measure; (2) motivation-based measure part 1; (3) filler questionnaire unrelated to the study; and (4) motivation-based measure part 2; or *money-based last*: with the money-based measure last. (It was not possible to counterbalance orders perfectly evenly across participants due to the constraints of using an experimenter-paced presentation in three different classes.) Within each class, participants were randomly assigned to one of the two *effort timing* conditions for the motivation-based measure, evenly counterbalanced across participants.

Conventional money-based PV. For each of two future rewards, participants were asked to specify the value that would make hypothetical cash prize options equally attractive: "$____ TODAY or $25 in 12 months"; "$____ TODAY or $10 in 12 months".

Motivation-based PV. In part 1 of the motivation-based measure, participants were told that, before executing large-scale studies, psychologists often give people detailed descriptions of those studies and ask them to predict how they would act (a method also used in Gilbert and Ebert (2002)). The procedure used in Studies 1a and 1b was then described: participants were asked to imagine taking part in a study for course credit requiring the completion of several tasks with the chance to earn a bonus payment on a computer task (i.e., the syntax task). The syntax task used in Studies 1a and 1b was described, and participants were told they would help to "test-pilot" this task by: spending 3 min on it, estimating the number of times the series of syntax appeared in the syntax passage, and then answering questions about the task. Participants were presented with the syntax task on paper for 3 min and prevented from using pens to make the task more comparable to the computer version used in Studies 1a and 1b, then asked to provide their count estimate and complete a series of questions, the order of which varied by effort timing condition. Participants in the same-time condition answered the reward valuation questions immediately following their count estimate: they were asked to state the additional time they would spend on the syntax task to achieve a correct count for a reward of $25 in 12 months, $10 in 12 months, $1 immediately after completing the study, $25 immediately and $10 immediately (presented in that order). Then they rated how effortful and how difficult the counting task was for them using 9-point scales, 1 (*Not at all*) to 9 (*Very much*), how much they liked it, 1 (*Disliked very much*) to 9 (*Liked very much*), and provided demographic information. Participants in the separated-in-time condition answered questions rating the effort, difficulty, and their liking of the counting task immediately following their count estimate. Then, to ensure a synchronized pace with the same-time condition participants, they briefly described how they made their count estimate before providing demographic information.

In part 2 of the motivation-based measure, i.e., following the delay provided by the filler task, the separated-in-time participants now answered the reward valuation questions, then they again provided the effortful, difficulty and liking ratings. Same-time participants only provided effortful, difficulty and liking ratings, and then briefly described how they made their count estimate.

Results

In this study, the two questions of most interest are: (1) whether the effort timing manipulation changed participants' PVs and (2) whether participants still showed the difference between the conventional money-based and the motivation-based PVs even though the motivational power of both immediate and future rewards was now assessed within-subjects.

The effects of manipulating timing of effort on PV

People appeared to behave on this prediction version of the syntax task in a similar way to the version used in Studies 1a and 1b: a 5 Reward ($1 immediately, $10 immediately, $25 immediately, $10 in 12 months, $25 in 12 months) × 2 Effort timing (same-time, separated-in-time) × 2 Order (money-based first, money-based last) ANOVA on participants' transformed stated times[9] showed the expected effect of reward, $F(4, 520) = 214.13$, $p < .001$, $\eta = .79$, where stated times increased with reward for the present reward conditions. Times for the future rewards fell between the $1 and $10 present reward conditions ($M_{\$10 \text{ in } 12 \text{ months}} = 2.06$ min, $M_{\$25 \text{ in } 12 \text{ months}} = 4.33$ min, $M_{\$1 \text{ immediately}} = 0.84$ min, $M_{\$10 \text{ immediately}} = 7.37$ min, $M_{\$25 \text{ immediately}} = 11.44$ min, and see Fig. 3; for *t*-tests comparing transformed stated times for future rewards with those for $1 and $10 immediate rewards, all *p*s < .001).

The ANOVA also revealed a marginal main effect of effort timing, $F(1, 130) = 3.07$, $p = .08$, $\eta = .15$.[10] Focused *t*-tests for each reward found effects for the $10 and $25 present rewards (*p*s < .06) and a marginally significant effect for the $25 in 12 months reward ($p = .10$), where the stated times in the same-time condition, i.e.,

[8] In this, as in all the studies, study participation was optional, consistent with IRB requirements. Students could fulfill an alternative requirement for course credit if they chose.

[9] Square root transformations of participants' predicted times increase the normality of the distributions of these variables as in Studies 1a and 1b. Also, as each participant provided time ratings for all five bonus conditions and so all comparisons were within-subject, it seemed unnecessary to remove participants who were extreme on these ratings. Nonetheless, for thoroughness the analyses were also conducted removing participants with extreme ratings (>2.5 *SD*s from mean for each bonus). They obtained the same pattern of results.

[10] This main effect was also significant when controlling for individual variation on subjects' perceptions of the task, by including covariates for subjects' rated effort, difficulty and/or liking of the task in the analysis.

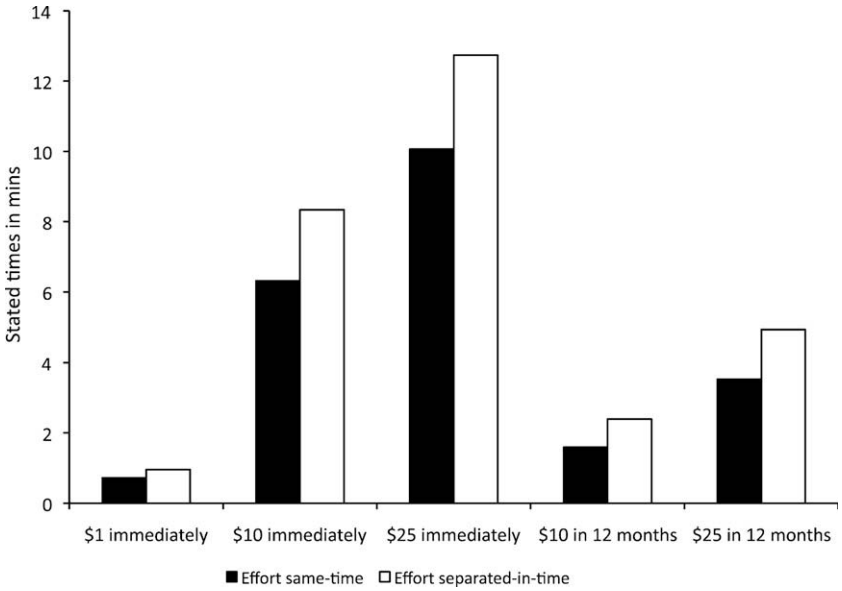

Fig. 3. Mean times stated by participants on syntax task for effort conditions in Study 2.

those provided immediately following the syntax task, were shorter than those made after a delay. (Stated times for the other reward conditions showed the same directional change. All are shown in Fig. 3.) However, the Effort timing × Reward interaction was not significant ($F < 1$) suggesting that, while the effort timing manipulation did not fail, i.e., it changed valuations, it had no overall effect on PV. To check the effect on PV more specifically, focused ANOVAs were also conducted on the present and future $25 reward conditions and on the present and future $10 reward conditions and they obtained very similar results (effort timing, $ps < .11$; Effort timing × Reward, $Fs < 1$). This lack of interaction suggests that the direct comparison of different present or future rewards with effort on this task is unlikely to account for the difference obtained between the conventional money-based and the motivation-based PVs.

Rather the effort timing manipulation seemed to change how the task was perceived. Following a delay after the task, all participants rated the syntax task as less effortful and less difficult and they liked it more: effortful: $M_{\text{same-time}} = 5.92$, $M_{\text{separated-in-time}} = 5.56$; difficulty: $M_{\text{same-time}} = 4.71$, $M_{\text{separated-in-time}} = 4.48$; liking: $M_{\text{same-time}} = 3.40$, $M_{\text{separated-in-time}} = 3.67$; by t-test, $ps < .04$. This change in perception of the task with effort timing could explain the change in times shown: if participants are willing to exert a particular level of effort for each reward, when the task is perceived as more effortful then the time they are willing to spend on the task is likely to be less.

Comparing money- and motivation-based PVs

Excluded data. Thirteen negative discounters (9% of participants), who gave PVs of greater than $10 or $25 when valuing $10 or $25 in 12 months respectively, were excluded from all analyses involving the conventional money-based PVs.

Analysis. Mean conventional money-based PVs for the $10 and $25 in 12 months rewards were $6.02 ($SD = $2.71) and $15.80 ($SD = $5.95), respectively. These values were compared statistically with the motivation-based PVs (those based on participants' stated times) for those participants using a similar analysis to Studies 1a and 1b, except that, as each participant had stated times for both present and future rewards, it was possible to model the relationship between the present rewards and time worked on the task using least-squares regression *for each participant*, by regressing each participant's (transformed) stated times for the present rewards against (the log of) the reward (ln $1, ln $10 and ln $25). (The mean R^2 for these individual regressions was .93, $SD = .13$.). So, each participant's regression coefficients were used with his or her (log) conventional money-based PVs of the future rewards to estimate equivalent time scores for that participant's conventional money-based PVs.

These estimates were compared with participants' stated times in a 2 Reward ($10 in 12 months, $25 in 12 months) × 2 Measure (money-based, motivation-based) × 2 Effort timing (same-time, separated-in-time) × 2 Order (money-based first, money-based last) ANOVA which revealed significant effects of reward, $F(1, 123) = 181.69$, $p < .001$, $\eta = .77$, and of measure, $F(1,123) = 119.73$, $p < .001$, $\eta = .70$, only, where the equivalent time scores based on participants' conventional money-based PVs were larger than the times participants actually stated. (Collapsing across effort timing and order conditions: money-based: $M_{\$10 \text{ in } 12 \text{ months}} = 4.89 \times$ min, $M_{\$25 \text{ in } 12 \text{ months}} = 8.92$ min; motivation-based: $M_{\$10 \text{ in } 12 \text{ months}} = 2.07$ min, $M_{\$25 \text{ in } 12 \text{ months}} = 4.33$ min; also see Fig. 4). This effect was significant for both future rewards ($ps < .001$). So, as in the previous studies, participants' motivation-based PVs were lower than their conventional money-based PVs (Hypothesis 1).

Finally, the conventional money-based and the motivation-based PVs again showed a low correlation across participants (Hypothesis 2): the average correlations between the transformed time variable and conventional money-based PV across experimental conditions were $r_{\$10 \text{ in } 12 \text{ months}} = .12$ and $r_{\$25 \text{ in } 12 \text{ months}} = .15$.

Discussion

Once again the motivation-based PVs for future rewards were lower than the conventional money-based PVs for those rewards for the same participants, using a somewhat different motivation-based measure from the previous studies, where participants simply stated how long they would work on the task for each of a series of present and future rewards. As before, even when motivational value and monetary value were matched for present rewards, they were different for future rewards.

This result was found even though the two measures of PV were obtained minutes apart and the motivation-based PV was calculated from rewards that were varied within-subjects, increasing the

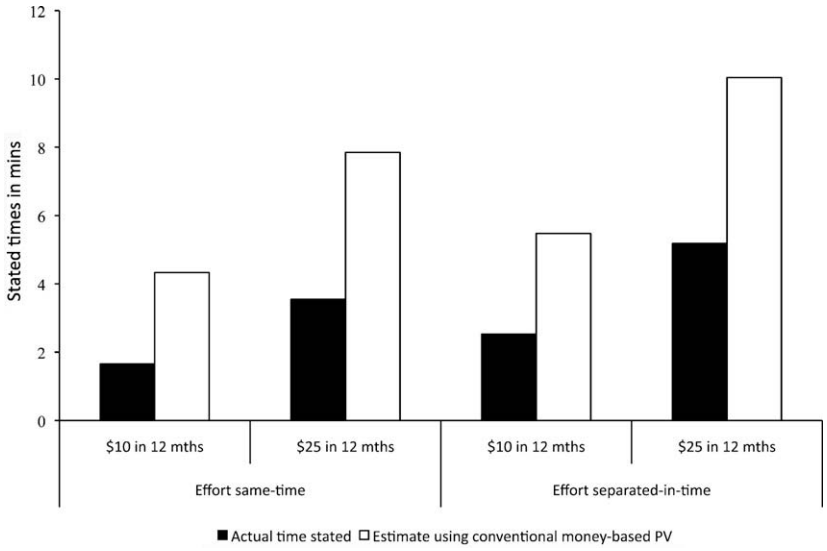

Fig. 4. Mean times stated by participants versus times estimated using conventional money-based measures for effort and reward conditions in Study 2.

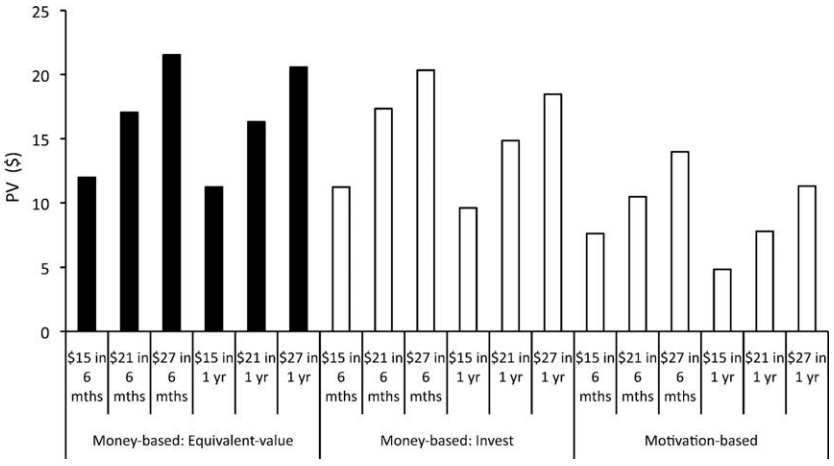

Fig. 5. Mean PVs for future rewards for the money-based equivalent-value and invest measures and for the motivation-based syntax measure in Study 3.

opportunity for consistency by participants in PV across the two measures. Nonetheless, *for each participant* future rewards had surprisingly low motivational value, given both the conventional money-based PV of those future rewards for that same participant and how long that participant said he or she would work for a present reward of equivalent value. The conventional money-based measure of PV used again overestimated the motivational value of future rewards (Hypothesis 1) and showed a low correspondence with motivational value across participants (Hypothesis 2).

In addition, this study found that the timing of effort exertion had no significant effect on motivation-based PV (or discounting), suggesting it is not the proximity of effort exertion in the motivation-based measure that causes the difference between money- and motivation-based measures. Rather than causing a greater difference in value between present and future rewards to result in lower PVs of future rewards for the motivation-based measure, effort timing had a similar effect for both present and future rewards resulting in no change in PV.

Study 3

In this study, I developed two new versions of the money-based PV measures for comparison with the motivation-based measure used in Study 2. Both versions used separate assessment of present and future rewards, just as on the motivation-based measure, enabling identical calculation of the PVs for each measure using these separate assessments. In addition, one version of the money-based measure used an invest valuation measure to examine the effect of loss aversion on the PVs for future rewards.

In this and the remaining studies, all valuation measures were presented to participants via computer, where participants clicked on a line to indicate their valuations. Also, these studies used more present rewards in smaller increments to allow more sensitive simple comparisons of valuations across valuation measures.

Method

Participants and design

Participants were 83 students at a mid-west public university (45 female, 38 male; mean age 21.3 years, $SD = 1.5$ years) who completed the study for partial course credit in a computer lab in group sessions of 1–7 participants, lasting up to half an hour.

All participants completed two money-based measures (*equivalent-value* and *invest*) and one motivation-based measure of PV for the same 16 rewards: 10 present and 6 future rewards. The PVs for the future rewards in all three measures were calculated using the

valuations of the present rewards for each measure for each participant and then compared across the three measures.

Procedure and materials

The study was conducted on computer (using E-prime experiment software version 1.1.). All participants completed three valuation measures, with the order counterbalanced, randomly assigned evenly across participants using the following three orders: order 1: equivalent-value, motivation-based, invest; order 2: invest, equivalent-value, motivation-based; order 3: motivation-based, invest, equivalent-value. For each measure, participants were given valuation instructions specific to the measure, then they valued a series of hypothetical monetary awards: one for practice ($16 today), then 16 awards presented one at a time in a new randomized order for each measure. The same 16 awards were used: 10 (varying from $3 to $30 in increments of $3) available today, 3 ($15, $21, and $27) available in 6 months, and 3 ($15, $21, and $27) available in 1 year. Participants valued each award at their own pace by clicking anywhere on a line to indicate the value. There were nine evenly spaced marks on the line, with labels for the middle and endpoints of the scale.

The three measures were: equivalent-value, motivation-based (both similar to the money-based and motivation-based measures, respectively in Study 2), and the invest measure. For the conventional equivalent-value measure, for each award participants were asked to "indicate what amount TODAY would be EQUALLY ATTRACTIVE to you (so you would be equally happy to receive either the award or the award you enter). The scale was labeled in cents: 0 cents, 1500 cents, and 3000 cents. For the motivation-based measure, as in Study 2, participants were presented with the syntax task for 3 min then asked to provide their count estimate. They were reminded that they had just spent 3 min (180 s) counting and asked to indicate, for each monetary award, "how long you would spend on the counting task if you would get this cash award for a CORRECT count". The scale was labeled in seconds: 0 s, 1500 s, and 3000 s. For the invest valuation measure, participants were asked to "indicate the MAXIMUM amount you would be WILLING TO INVEST TODAY to receive the award", using the same scale as for the equivalent-value measure. Following the measures, the participants indicated their age and gender, and were thanked for their participation.

Results

Participants' valuations of present and future rewards and excluded data

For each valuation made, the point where the participant clicked was converted to a ratio of the scale, i.e., varying from 0 to 1. (Clicks beyond ±2% of the scale ends were recorded as missing: three valuations, i.e., 0.07%.)

Seven negative discounters (8% of participants) were identified and excluded using similar criteria to Studies 1a, 1b and 2. Specifically, each participant's future reward valuation on the three measures was subtracted from the corresponding present reward valuation (e.g., valuation for $15 in 1 year was subtracted from valuation for $15 today). This difference was coded as negative if it was larger than −0.08 (i.e., ±2% × 2 = ±4% or 8% of the scale, to allow for some inaccuracy in the participant clicking on the scale for both the future and present reward). Negative discounters were defined as those who showed negative discounting on more than half of the future rewards for any of the valuation measures.

To enable direct statistical comparisons across valuation measures, participants' PVs for each future reward were estimated in "today dollars" using the values for each present reward. Specifically, for each participant for each of the three valuation measures, the valuation for each present reward was regressed on the dollar values of those rewards to estimate regression coefficients, then the valuation for each future reward was combined with the individual's regression coefficients to estimate the PV (in "today dollars") of each future reward for that participant. Some participants showed almost no change in valuation for different present rewards, reflecting either a lack of influence of the rewards on the participant or a lack of care in valuation by the participant. The data of eight such participants, who had either particularly low regression coefficients for present reward (<.0001) or particularly low R^2s (<.10) on at least one of the three valuation measure regressions, were excluded from further analyses.

Do the money- and motivation-based measures differ on PVs?

The effect of valuation measure on participants' PVs was examined in two ways: (1) by comparing mean valuations for future and present rewards *within* each measure and (2) by directly comparing estimates of participants' PVs for future rewards *across* measures.

Comparisons of present and future reward valuations. The two money-based valuations for future rewards (i.e., from the equivalent-value and invest measures) were reliably considerably larger than the motivation-based valuations for the same future rewards. Table 1 diagrams the results of paired *t*-tests comparing each future reward valuation with all present reward valuations for each measure. It shows that, for example, on the motivation-based measure, the valuation of $27 in 6 months was reliably larger than $9 today, reliably smaller than $18 today, but not reliably different from $12 and $15 today. In comparison, for both the equivalent-value and the invest measures, the valuation for this reward was reliably larger than $18 today, smaller than $24 today, but not reliably different from $18 today.

Participants valuations for both the equivalent-value and invest measures use the same scale, so I also used paired *t*-tests to directly compare valuations for present rewards and for future rewards for these measures. Consistent with research that people expect losses to have a larger impact than gains (Kahneman, 2003; Kerner et al., 2006), the valuations in the invest measure were smaller than those in the equivalent-value measure, $ts > 2.81$, $ps < .007$, $rs > .32$.

Effect of measure on PV estimates. Participants' PVs for the three future rewards for each measure were submitted to a 3 Measure (equivalent-value, invest, syntax) × 2 Future time (in 6 months, in 1 year) × 3 Reward ($15, $21, $27) repeated measures ANOVA. (Mean PVs are shown in Fig. 5). This revealed significant main effects of: future time, $F(1, 67) = 27.37$, $p < .001$, $\eta = .54$, where PVs for a longer time into the future were smaller, $M_{\text{in 1 year}} = 12.77$, $M_{\text{in 6 months}} = 14.61$; reward, $F(2, 134) = 135.98$, $p < .001$, $\eta = .82$, where larger rewards had larger PVs, $M_{\$15} = 9.41$, $M_{\$21} = 13.97$, $M_{\$27} = 17.70$; and measure, $F(2, 134) = 39.93$, $p < .001$, $\eta = .61$, where the motivation-based syntax measure had the lowest PVs, $M_{\text{syntax}} = 9.33$, $M_{\text{invest}} = 15.31$, $M_{\text{equivalent-value}} = 16.45$. These main effects were qualified by significant Measure × Future time, $F(2, 134) = 3.52$, $p = .03$, $\eta = .22$, and Measure × Reward interactions, $F(4, 268) = 3.13$, $p = .02$, $\eta = .21$.

Paired *t*-tests were used to compare the PV for each future reward across measures. Consistent with Studies 1a, 1b and 2, these focused tests found that the PVs for both the money-based measures (equivalent-value and invest) were significantly larger than the PVs for the motivation-based syntax measure, $ts > 3.52$, $ps < .001$, $rs > .40$ (and see Fig. 5). The PVs for the equivalent-value and invest measures were not reliably different at the .05 significance level, though two comparisons showed marginally significant differences ($ps > .08$), where PVs on the equivalent-value measure were slightly larger.

Table 1
Comparison of present and future valuations for PV measures in Study 3.

$ today	Money-based: equivalent-value						Money-based: invest						Motivation-based					
	$ in 6 months			$ in 1 year			$ in 6 months			$ in 1 year			$ in 6 months			$ in 1 year		
	15	21	27	15	21	27	15	21	27	15	21	27	15	21	27	15	21	27
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	*ns*	–	–	*ns*	*ns*	–
9	–	–	–	–	–	–	–	–	–	*ns*	–	–	*ns*	*ns*	–	+	*ns*	*ns*
12	*ns*	–	–	*ns*	–	–	*ns*	–	–	+	–	–	+	*ns*	*ns*	+	+	*ns*
15	+	*ns*	–	+	*ns*	–	+	–	–	+	*ns*	–	+	+	*ns*	+	+	+
18	+	+	–	+	+	–	+	*ns*	–	+	+	*ns*	+	+	+	+	+	+
21	+	+	*ns*	+	+	*ns*	+	+	*ns*	+	+	+	+	+	+	+	+	+
24	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
27	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
30	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

–, $ today is valued less than $ in future ($p \leqslant .05$).
ns, $ today is not different from $ in future ($p > .05$).
+, $ today is valued more than $ in future ($p \leqslant .05$).

Correlations of PVs across measures. For each measure, I calculated a summary PV value from the means of the six future reward PVs. These summary PVs were significantly positively correlated across measures. The correlation between the equivalent-value and invest measures was somewhat larger ($r(66) = .51$, $p < .001$), than the correlation between each of those measures and the motivation-based measure ($r_{\text{equivalent-value}}(66) = .36$, $p = .003$, and $r_{\text{invest}}(66) = .45$, $p < .001$).

Discussion

Again the motivation-based PVs for future rewards were lower than the money-based PVs for those rewards for the same participants (Hypothesis 1). This occurred for both the equivalent-value and invest versions of the money-based PV measures. So both versions of the money-based measures of PV overestimated the motivational value of future rewards.

Using an invest version of the money-based measure did affect valuation: Participants' valuations of rewards on the payment (invest) version of the money-based measure were lower than those on the equivalent-value measure, consistent with findings that people expect losses to have a larger impact than gains (Kahneman, 2003; Kerner et al., 2006). However, this difference occurred to similar extent for both present and future rewards, resulting in no overall effect on PV (i.e., the relative measure of future to present rewards). The lack of difference in PV between the equivalent-value and invest money-based measures combined with the similar difference in PV between each of these money-based measures and the motivation-based measure suggests that loss aversion in the motivation-based measure is unlikely to account for the consistent difference observed between money-based and motivation-based measures of PV.

The PVs obtained using the motivation-based measure showed a moderate relationship with the PVs obtained using the two money-based measures, perhaps due to the identical methodology used in this study for both the money- and motivation-based measures for presentation of the stimuli and response mode, i.e., both used separate assessments of the same present and future rewards valued on a visual-analog scale. Despite the similar methodology across measures, this relationship was somewhat smaller than the relationship between the PVs for the two money-based measures, demonstrating some evidence of convergent and discriminant validity (Campbell & Fiske, 1959) for the money-based versus motivation-based measures of PV (Hypothesis 2).

Study 4

In this study, I develop a new motivation-based measure, similar to the motivation measure used in Studies 2 and 3, but based on a different task. As mentioned previously, according to the financial incentive literature (Camerer & Hogarth, 1999; Jenkins et al., 1998) simple endurance tasks, such as pain endurance, tend to be sensitive to financial incentives. For the new motivation-based measure, participants listened to an unpleasant noise before estimating how many times they would be willing to listen to the same noise for a series of present and future rewards. This study also used the conventional equivalent-value version of the money-based measure and the motivation-based measure based on the syntax task, both used in Study 3. The motivation-based measure with the noise task provides a conceptual replication of the motivation-based measure using the syntax task, and was expected to result in similar PVs and to show convergent validity with that measure. Finally, this study examines the relationship of these different PV measures with additional measures intended to assess individuals' intertemporal preference.

Method

Participants and design

Participants were 163 students at a mid-west public university (86 female, 77 male; mean age 20.8 years, $SD = 1.7$ years) who completed the study for partial course credit in a computer lab in group sessions of 1–8 participants, lasting up to half an hour.

The study was identical to Study 3, except that, in place of the invest version of the money-based measure, all participants completed a new motivation-based measure based on a different task: the noise task. Therefore each participant completed one money-based measure (*equivalent-value*) and two motivation-based measures of PV (*syntax* and *noise*) for the same 16 rewards: 10 present and 6 future rewards. The PVs for the future rewards in all three measures were calculated using the valuations of the present rewards for each measure for each participant and then compared across the three measures.

Procedure and materials

For the noise task, participants listened to a 30-s sound clip of an unpleasant noise. They were then asked to indicate, for each monetary reward, "how many times you would be WILLING TO LISTEN TO THIS SOUND to receive the award". The scale was the same as those in Study 3, but labeled: 0 times, 15 times, and 30

times. Following the measures, the participants indicated their age and gender. The order of the measures was counterbalanced, randomly assigned evenly across participants, using the following three orders: order 1: money-based, syntax, noise; order 2: noise, money-based, syntax; order 3: syntax, noise, money-based.

Part-way through running this study, a questionnaire was added after the measures (completed by 59 participants) that contained a short filler task followed by several questions assessing inter-temporal preference in the monetary and two non-monetary domains: health and magazine preference. These were:

(1) Four questions on health behavior for which participants rated: the extent he/she was currently motivated to follow a healthy diet because of future concerns, present concerns, and motivated to exercise because of future concerns, present concerns (examples were provided), using a 9-point scale, 1 (*Not at all*) to 9 (*Very much*).
(2) Five questions from previous research that were intended to capture individual differences in intertemporal preference. There were three questions from Frederick (2005) which involved choosing between two options available in the nearer or more distant future: (a) 30-min massage in 2 weeks or a 45-min massage in November (i.e., 7 months distant); (b) lose $1000 this year or lose $2000 next year; (c) tooth pulled today or tooth pulled in 2 weeks. There were two questions from Liu and Aaker (2007): one question required participants to allocate $400 from a federal tax cut between three options, (a) spend it, (b) put it in a short-term savings/investment account, and (c) put it in a long-term savings/investment fund; the other asked for strength of preference between two magazine brands which varied in their long and short-term benefits: Magazine A which was "not necessarily in your main domain of professional interest. However, just imagining yourself reading this magazine makes you feel good", and Magazine B which was "in your main domain of professional interest. However, just imagining yourself reading this magazine does not make you feel good"; using a 9-point scale, 1 (*Definitely brand A*) to 9 (*Definitely brand B*).

Results

Participants' valuations of present and future rewards and excluded data

The analysis of the data was very similar to that in Study 3. Participants' valuations were calculated as scale ratios. (Clicks beyond ±2% of the scale ends were recorded as missing: 21 valuations, i.e., 0.27%.) The same criteria as in Study 3 were used to identify and exclude 22 (13%) negative discounters. Participants' PVs for each future reward were also estimated in "today dollars" using regressions, and 17 additional participants, with very low regression coefficients or low R^2s (using the same criteria as in Study 3), were excluded from further analyses.

Do the money- and motivation-based measures differ on PVs?

As in Study 3, the effect of measure was examined in two ways: (1) comparing valuations for present and future rewards within each measure and (2) testing the effect of measure on estimates of participants' PVs for future rewards.

Comparisons of present and future reward valuations. Once again, conventional money-based PVs for future rewards were reliably larger than motivation-based PVs (i.e., those for both the syntax and noise tasks) for the same future rewards. This is shown in Table 2, which diagrams the results of paired *t*-tests comparing future with present reward valuations for each measure just as for Study 3. So, for example, on both motivation-based measures, the valuation of $21 in 1 year was reliably larger than $6 today, reliably smaller than $12 today, but not reliably different from $9 today. In comparison, for the conventional money-based measure, the valuation for this reward was reliably larger than $12 today, smaller than $18 today, but not reliably different from $15 today.

Effect of measure on PV estimates. Participants' PVs for the three future rewards for each measure were submitted to a 3 Measure (money-based, noise, syntax) × 2 Future time (in 6 months, in 1 year) × 3 Reward ($15, $21, $27) repeated measures ANOVA. (Mean PVs are shown in Fig. 6). The results were very similar to those in Study 3. There were significant main effects of: future time, $F(1, 121) = 59.41$, $p < .001$, $\eta = .57$, where PVs for a longer time into the future were smaller, $M_{\text{in 1 year}} = 9.88$, $M_{\text{in 6 months}} = 11.63$; reward, $F(2, 242) = 166.96$, $p < .001$, $\eta = .76$, where larger rewards had larger PVs, $M_{\$15} = 7.59$, $M_{\$21} = 11.31$, $M_{\$27} = 13.35$; and measure, $F(2, 242) = 75.19$, $p < .001$, $\eta = .62$, where the conventional money-based measure had the highest PV, $M_{\text{syntax}} = 8.45$, $M_{\text{noise}} = 7.51$, $M_{\text{money-based}} = 16.30$. These main effects were qualified by significant Measure × Future time, $F(2, 242) = 7.60$, $p = .001$, $\eta = .24$, and Measure × Reward interactions, $F(4, 484) = 14.10$, $p < .001$, $\eta = .32$.

Paired *t*-tests were used to compare the PV for each future reward across measures. conventional money-based PVs were significantly larger than the PVs for both motivation-based measures, i.e., noise and syntax, $ts > 4.21$, $ps < .001$, $rs > .36$), while the PVs for the two motivation-based measures were not different from each other ($ps > .14$). (Mean PVs for each measure are shown in Fig. 6.)

Table 2
Comparison of present and future valuations for PV measures in Study 4.

$ today	Money-based						Motivation-based: noise						Motivation-based: syntax					
	$ in 6 months			$ in 1 year			$ in 6 months			$ in 1 year			$ in 6 months			$ in 1 year		
	15	21	27	15	21	27	15	21	27	15	21	27	15	21	27	15	21	27
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	*ns*	–	–	–	–	–	*ns*	–	–
9	–	–	–	–	–	–	+	*ns*	–	+	*ns*	*ns*	*ns*	–	–	+	*ns*	*ns*
12	*ns*	–	–	*ns*	–	–	+	+	*ns*	+	+	+	+	*ns*	*ns*	+	+	+
15	+	–	–	+	*ns*	–	+	+	+	+	+	+	+	*ns*	*ns*	+	+	+
18	+	*ns*	–	+	+	–	+	+	+	+	+	+	+	+	+	+	+	+
21	+	+	*ns*	+	+	*ns*	+	+	+	+	+	+	+	+	+	+	+	+
24	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
27	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
30	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

–, $ today is valued less than $ in future ($p \leqslant .05$).
ns, $ today is not different from $ in future ($p > .05$).
+, $ today is valued more than $ in future ($p \leqslant .05$).

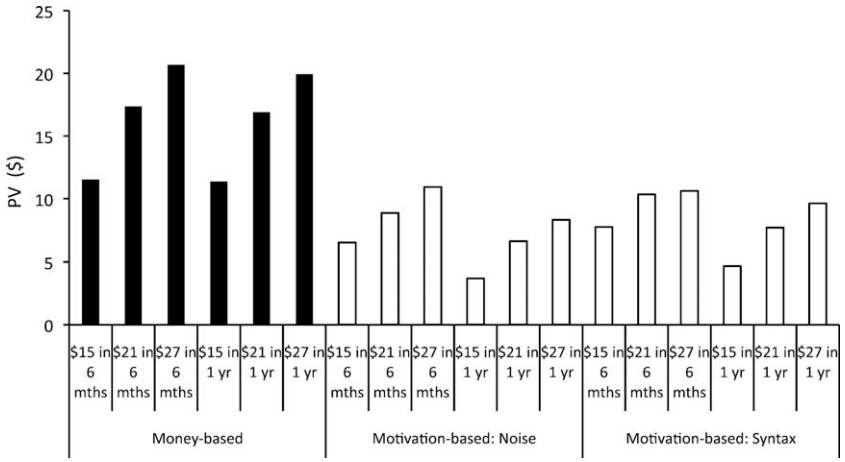

Fig. 6. Mean PVs for future rewards for the conventional money-based measure and for the motivation-based noise and syntax measures in Study 4.

Correlations of PVs across measures. For each measure, I calculated a summary PV value from the means of the six future reward PVs. These summary PVs were significantly positively correlated across measures. The correlations between the conventional money-based measure and the two motivation-based measures, were somewhat smaller ($r_{noise}(121) = .33$, $p < .001$, and $r_{syntax}(121) = .27$, $p = .002$), than the correlation between the two motivation-based measures ($r(122) = .45$, $p < .001$).

Correlations with other intertemporal preference measures. Correlations between the summary PVs for the three measures and the variables in the additional questionnaire, intended to assess individual differences in inter-temporal preference, were mostly not significant though directional results with these variable were similar for the three PV measures. The only significant correlations were between the motivation-based PVs and two questions in the monetary domain: the motivation-based noise PV with the choice between losing $1000 now and $2000 next year, $r(48) = -.35$, $p = .01$; and the motivation-based syntax PV with the question assessing participants' spend (rather than invest) allotment, $r(55) = -.30$, $p = .03$. Both correlations are in the expected direction, that is, participants with higher PVs on these measures are relatively more "patient", preferring to lose money now rather than later and allotting less money to spend now versus investing it for later.

Discussion

Once again the motivation-based PVs for future rewards were lower than the conventional money-based PVs for those rewards for the same participants. In this study, this finding was extended to a different motivation-based measure of PV, one that involved enduring an unpleasant noise. PVs obtained using this new motivation-based noise measure resembled those obtained using the existing motivation-based syntax measure and were different from those using the conventional money-based measure: mean PVs were similar for the two motivation-based measures and significantly different from mean PVs for the conventional money-based measure (Hypothesis 1), and correlations between PVs from the two motivation-based measures (noise and syntax) were somewhat higher than those with PVs from the conventional money-based measure (Hypothesis 2).

As in Study 4, the presentation and response mode for valuation of the rewards used were identical for the money- and motivation-based measures and, perhaps because of this, the PVs for the two motivation-based measures showed a moderate relationship with the PVs for the conventional money-based measure. Nonetheless, also as in Study 4, the pattern of correlations between these three measures provides some support for convergent and discriminant validity for the conventional money-based versus motivation-based measures of PV (Campbell & Fiske, 1959).

The PVs for the three measures showed similar patterns of results with other measures of intertemporal preference, though only correlations between the motivation-based measures and measures in the monetary domain were large enough to reach significance, providing some support for the construct validity of the motivation-based measures used here (Campbell & Fiske, 1959).

Study 5

This study examines whether the difference in PVs obtained using money- and motivation-based measures may be explained by the use of different valuation strategies in the two measures. First, this study measures to what extent people use a more affect-based approach in making their valuations versus an anchor-and-adjustment approach. Based on previous research, I expect that when valuing future rewards in the conventional money-based PV measure people will be more likely to use an anchor-and-adjustment approach (Ebert, 2001), but when valuing future rewards in the motivation-based PV measure people will be more likely to use an affect-based approach (Pham, 2007). Also as proposed earlier, I expect that greater use of an anchor-and-adjustment approach relative to an affect-based approach may result in larger PVs, either because an affect-based approach to valuation may better capture the low emotional involvement and arousal characteristic of future rewards relative to present rewards or because adjustment in an anchor-and-adjustment approach tends to be insufficient (Gilbert, 2002; Tversky & Kahneman, 1974).

In addition to examining differences in the use of valuation strategies between the conventional money-based and the motivation-based measures of PV, I try to change participants' use of strategies on the measures by applying time pressure. Consistent with past research, I expect that an affect-based approach for making future valuations may be faster and easier to use (see review by Pham (2007)), so participants who predominantly use this approach for either the conventional money-based or the motivation-based measures will show less effect of time pressure on the valuation strategy they use and on their PVs. However, participants who predominantly use an anchor-and-adjustment approach, which tends to require more cognitive resources (Gilbert, 2002), are likely to show greater effect of time pressure, both on the valuation strategy they use and on their PVs.

Time pressure should change PV, but the direction of the effect is hard to predict. It may reduce adjustment for an anchor-and-adjustment approach resulting in higher PVs for future rewards. Alternatively, it may cause participants to switch to a faster affect-based strategy, leading to lower PVs for future rewards.

Method

Participants and design

Participants were 119 students at a mid-west public university (54 female, 65 male; mean age 21.0 years, $SD = 2.4$ years) who completed the study for partial course credit in a computer lab in group sessions of 8–10 participants lasting up to half an hour.

The study used the money-based equivalent-value measure from Studies 3 and 4, and the motivation-based measure using the noise task from Study 4. All participants completed both measures with the order counterbalanced and in one of two scale conditions (with marks as in past studies, $n = 58$, and without marks, $n = 61$), randomly assigned to one of the four Order × Scale conditions. Time pressure was manipulated within-subjects, where participants first completed both valuation measures with *no pressure* and then under *pressure*. Participants valued the same 18 rewards for each measure: 10 present rewards, and 4 future rewards that were each presented twice. The PVs for the future rewards were calculated using the valuations of the present rewards for each time pressure condition for each measure for each participant and then compared.

Procedure and materials

Participants first completed the money- and motivation-based measures at their own pace (no pressure condition) then, after being told they would now have "very limited time (less than 2 s)" to respond for each valuation, they completed both measures under time pressure (pressure condition). For each measure, there were 21 trials, 3 practice and 18 experiment trials. For each trial: (1) participants saw the valuation question for that measure, (2) they clicked in a small box centered in the screen, (3) the award for valuation was presented, (4) after 1500 ms the response scale appeared, (5) participants valued the award by clicking on the scale, and (6) their responses and response times from when the scale appeared were recorded. In the *no pressure* condition, participants had unlimited time to respond, while in the *pressure* condition they had to respond within 2000 ms following the appearance of the scale.

The three awards presented in the practice trials were: \$16 today, \$12 in 6 months, and \$20 in 1 year, in that order. The 18 awards in the experiment trials were: 10 available today (varying from \$3 to \$30 in increments of \$3), 2 available in 6 months 3 (\$15, \$27) each presented twice, and 2 available in 1 year (\$15, \$27) each presented twice. For each measure the 18 awards were presented in a new randomized order.

In previous studies, the response scale for each measure had marks regularly spaced to aid participants' valuations. However, simply using this scale design could conceivably prompt participants to use an anchor-and-adjustment valuation strategy, especially in the conventional money-based measure where the marks exactly correspond to the award values (\$3, \$6, etc). To check that it was not simply scale design that caused participants' to respond differently for the two different measures, in this study participants responded using one of two *scale* conditions, on scales with *marks* (identical to those used in Study 4) or on scales with *no marks* (simply a line with the endpoints labeled, \$0 and \$35, and 0 times and 35 times, for the money- and motivation-based measures, respectively).

Following the computer task, participants completed a questionnaire asking about their valuation strategy for the future reward for each of the four measure conditions, i.e., money- and motivation-based measures both with and without time pressure. They indicated to what extent two valuation strategies, *adjustment* and *affect-based*, described what they did when valuing the future awards, on a 9-point scale, 1 (*Does not describe what I did at all*) to 9 (*Very much describes what I did*). The descriptions were: (1) adjustment: "For each award, *first* I worked out what point I would click for that \$ award if it was available today, *then* I adjusted from that point to take into account when the award was available (i.e., in 6 months, or in a year)" and (2) affect-based: "For each award, I imagined how getting that money would feel, and I imagined how getting the amount of money I selected would feel (.. how listening to the noise for a number of times would feel), and I tried to match them in my mind". Lastly, if these methods did not describe what they did very well, they were asked to describe what they did for each measure.

Finally, all participants completed the Zimbardo Time Perspective Inventory (Zimbardo & Boyd, 1999). This is a 56-item measure that assesses five time perspective factors, including one that assesses general future orientation. Participants rated to what extent each item was characteristic of them on a 5-point scale, 1 (*Very uncharacteristic*) to 5 (*Very characteristic*).

Results

Participants' valuations of present and future rewards and excluded data

Valuations for the present and future rewards were calculated as in Studies 3 and 4. (Clicks that were either beyond ±2% of the scale ends or that were recorded after the 2000 ms time limit in the pressure condition were counted as missing: $n = 406$ valuations, i.e., 3%). In addition, for each participant for each measure, the two scale ratios for each future reward were averaged so each participant had one valuation for each reward. Using the same criteria as in Studies 3 and 4, 12 negative discounters and 9 participants with very low regression coefficients or R^2s for the regressions used to estimate PVs were excluded from further analyses.

Participants' PVs for the four future rewards (for each measure) were strongly intercorrelated: mean rs, (calculated by averaging the inter-correlations of the PVs for these rewards within each of the four Order × Scale conditions, then averaging across these conditions) were: $r_{\text{money-based no pressure}} = .76$, $r_{\text{money-based pressure}} = .69$, $r_{\text{motivation-based no pressure}} = .53$, $r_{\text{motivation-based pressure}} = .70$. To simplify interpretation of results in this study, these PVs were averaged to form a summary PV of the future rewards for each measure for each time pressure condition.

Do the money- and motivation-based measures differ on PVs and valuation strategies?

All participants first completed valuations for each measure with no pressure, replicating Studies 3 and 4. Therefore, I first compare PVs, valuation strategies used, and time taken for valuation for the money- and motivation-based measures for the no pressure conditions.

Effect of measure on PV estimates. The summary PVs for future rewards were submitted to a 2 Measure (money-based, motivation-based) × 2 Scale (marks, no marks) repeated measures ANOVA, which revealed only a significant effect of measure, $F(1, 98) = 34.22$, $p < .001$, $\eta = .51$, where the PV for the conventional money-based measure was greater than for the motivation-based measure, consistent with the results in previous studies. This result did not depend on what type of scale was used: the Measure × Scale interaction was not significant ($F < 1$) and the effect of measure was similar for both marks and no marks conditions

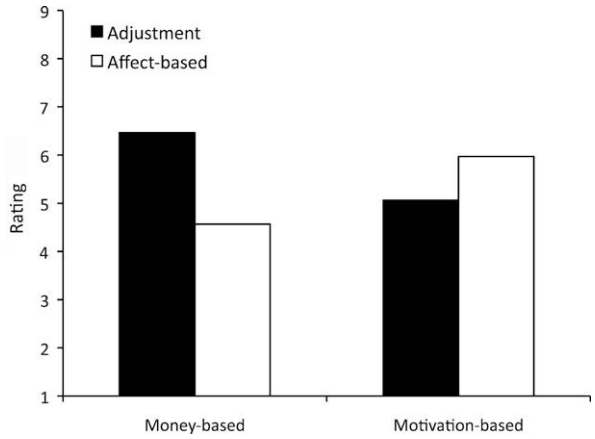

Fig. 7. Mean ratings of valuation strategies used for the conventional money-based and the motivation-based measures in Study 5.

(marks: $t(47) = 5.84$, $p < .001$, $r = .65$; no marks: $t(51) = 3.41$, $p < .001$, $r = .43$).

Effect of measure on valuation strategy. For both measures, participants' ratings of their use of the two valuation strategies were reasonably high (see Fig. 7), suggesting that these descriptions captured participants' valuation strategies quite well. Also, they were significantly negatively correlated ($r_{\text{money-based}} = -.19$, $r_{\text{motivation-based}} = -.27$, $ps < .05$),[11] suggesting that participants who used one strategy more used the other strategy less.

Participants' ratings for the two valuation strategies were submitted to a 2 Measure (money-based, motivation-based) × 2 Valuation strategy (adjustment, affect-based) × 2 Scale (marks, no marks) repeated measures ANOVA. This revealed a significant Measure × Valuation strategy interaction, $F(1, 97) = 35.33$, $p < .001$, $r = .52$: for the conventional money-based measure, participants used the adjustment strategy more than the affect-based strategy ($M_{\text{adjustment}} = 6.46$, $M_{\text{affect-based}} = 4.57$, $t(98) = 5.30$, $p < .001$, $r = .47$), while, for the motivation-based measure, they used the affect-based strategy more than adjustment ($M_{\text{adjustment}} = 5.06$, $M_{\text{affect-based}} = 5.97$, $t(98) = -2.19$, $p = .03$, $r = .22$); and participants used the adjustment strategy more and the affect-based strategy less for the conventional money-based measure compared to the motivation-based measure (adjustment: $t(98) = 5.13$, $p < .001$, $r = .46$; affect-based: $t(98) = -5.18$, $p < .001$, $r = .46$). So, participants' use of the two valuation strategies differed across the money- and motivation-based measures.

Just as for the results with PV, this result did not depend on what type of scale was used: the Measure × Valuation strategy × Scale interaction was not significant ($F < 1$) and the Measure × Valuation strategy interaction effect was similar for both marks and no marks conditions (marks: $F(1, 46) = 19.96$, $p < .001$, $r = .55$; no marks: $F(1, 51) = 14.90$, $p < .001$, $r = .48$).

Relationship between PV and valuation strategy. Participants' PVs for future rewards are different for the two measures (they value the rewards more on the conventional money-based measure) and they use the two valuation strategies to different extents in the two measures (they use the adjustment strategy more and the affect-based strategy less on the conventional money-based measure). But does the difference in valuation strategies used for each measure help to explain the difference in PV of future rewards on each measure? For both measures, participants' use of the affect-based strategy showed a significant negative correlation with their PVs on those measures ($r_{\text{money-based}} = -.28$, $r_{\text{motivation-based}} = -.24$, $ps < .02$),[12] while the correlations with the adjustment strategy were close to zero and not significant ($ps > .73$). Therefore, greater use of the affect-based strategy corresponds to lower PVs for future rewards. This helps to account for the lower PVs given on the motivation-based measure, on which participants make more use of the affect-based strategy.

Effect of measure on time taken to make valuations. A log transform of response times for each reward was used to improve normality of the distributions. Averages of the transformed response times were then calculated for the present and for the future rewards on each measure for each participant. A 2 Measure (money-based, motivation-based) × 2 Reward time (today, future) × 2 Scale (marks, no marks) repeated measures ANOVA on these average transformed response times revealed a significant main effect of measure, $F(1, 98) = 43.07$, $p < .001$, $r = .55$, qualified by a Measure × Reward time interaction, $F(1, 98) = 6.10$, $p = .02$, $r = .24$. (Means are shown in Fig. 8.) Overall, participants spent more time making valuations for the conventional money-based measure. In addition, participants spent more time valuing future than present rewards for the conventional money-based measure, $t(99) = 3.86$, $p < .001$, $r = .36$, but they spent similar time valuing future and present rewards for the motivation-based measure, $p = .23$.

These results are consistent with the valuation strategies used predominantly for each measure. Predominant use of an adjustment strategy, as on the conventional money-based measure, results in slower valuations on average than does more use of an affect-based strategy, as on the motivation-based measure. This is especially the case for valuation of future rewards using an adjustment strategy, for which participants first anchor on the value of the reward before adjusting for the delay until receipt of the reward (Ebert, 2001), while valuation of present rewards does not require additional time for adjustment. In contrast, valuations using an affect-based strategy involve the same process for both present and future rewards, and so take a similar time for both.

Just as with PV and valuation strategy, these results did not depend on what type of scale was used: the Measure × Valuation strategy × Scale interaction was not significant ($F < 1$), and the results were similar for both marks and no marks conditions (marks: money-based measure $t(47) = 2.96$, $p = .005$, $r = .40$, motivation-based measure $p = .51$; no marks: $t(51) = 2.47$, $p = .02$, $r = .33$).

What is the effect of time pressure for each measure?

I expected that the effect of time pressure on PV for future rewards would depend on its effect on the strategy used by participants under pressure. Furthermore, the effect of time pressure is likely to depend on the predominant strategy used by participants. Participants who relied predominantly on an affect-based strategy (which corresponded to faster valuation times) are likely to show little effect of time pressure on the strategy they used and hence on their PVs. However, participants who relied predominantly on an adjustment strategy (which corresponded to slower valuation times, especially for future rewards) are likely to show greater effect of time pressure on the strategy they used and on their PVs. Therefore, in the following analyses, participants were first divided according to the predominant strategy they used on the measure examined.

Effect of time pressure on PV for future rewards. For the conventional money-based measure, most participants (69/100) used the

[11] These correlations were very similar when calculated separately for each Order × Scale conditions then averaged: $r_{\text{money-based}} = -.20$, $r_{\text{motivation-based}} = -.26$.

[12] These correlations were very similar when calculated separately for each Order × Scale conditions then averaged: $r_{\text{money-based}} = -.25$, $r_{\text{motivation-based}} = -.21$.

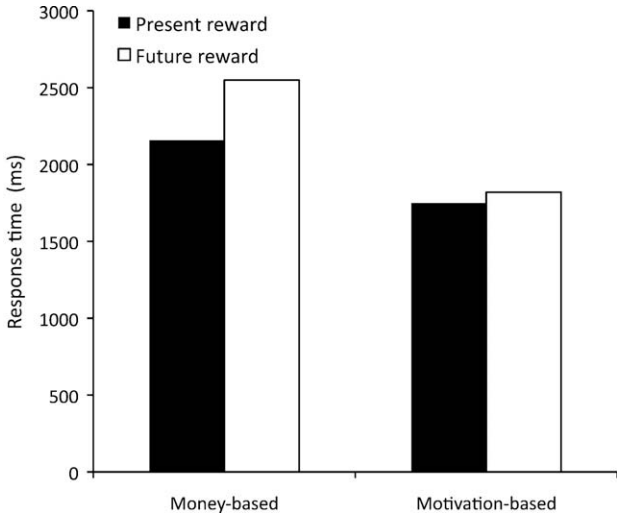

Fig. 8. Mean response times for the conventional money-based and the motivation-based measures in Study 5.

adjustment strategy more than the affect-based strategy (money-based adjusters), 24 used the affect-based strategy more (money-based feelers), and 7 participants used the two strategies equally. The summary PVs were submitted to a 2 Time pressure (no pressure, pressure) × 2 Scale (marks, no marks) repeated measures ANOVA for each of the adjuster and feeler groups. This revealed a significant effect of time pressure for the adjusters only, $F(1, 67) = 4.08$, $p = .05$, $\eta = .24$, where participants' PVs for future rewards decreased with time pressure ($M_{\text{no pressure}} = 15.06$, $M_{\text{pressure}} = 14.20$). For the feelers, these means were $M_{\text{no pressure}} = 12.30$, $M_{\text{pressure}} = 13.01$, i.e., directionally opposite to those for adjusters, though not significantly different ($F < 1$). The Time pressure × Scale interaction was not significant for either group (Fs < 1).

For the motivation-based measure, 36 participants used the adjustment strategy more than the affect-based strategy (motivation-based adjusters), 52 used the affect-based strategy more (motivation-based feelers), and 12 participants used the two strategies equally. A similar analysis on the PVs for the motivation-based measure for these adjusters and feelers revealed no significant main effects or interactions with time pressure, Fs < 1.22, ps > .27, ηs < .15.

Effect of time pressure on valuation strategies. Similar analyses, i.e., with the same adjuster and feeler groups, were used to examine the effect of time pressure on valuation strategies used for the money- and motivation-based measures. For each measure, participants' ratings for the two valuation strategies were submitted to a 2 Time pressure (no pressure, pressure) × 2 Valuation strategy (adjustment, affect-based) × 2 Scale (marks, no marks) repeated measures ANOVA. For both groups on both measures, the effect of valuation strategy was significant as expected, Fs > 33.93, ps < .001, ηs > .71, consistent with each group's dominant strategy, i.e., adjusters used the adjustment strategy more and feelers used the affect-based strategy more. In addition there was a significant or marginally significant main effect of time pressure, Fs > 2.92, ps < .09, ηs > .24, where participants reported using these strategies somewhat less overall under time pressure (money-based measure: adjusters, $M_{\text{no pressure}} = 5.49$, $M_{\text{pressure}} = 5.06$; feelers, $M_{\text{no pressure}} = 5.38$, $M_{\text{pressure}} = 4.60$; motivation-based measure: adjusters, $M_{\text{no pressure}} = 5.59$, $M_{\text{pressure}} = 4.98$; feelers, $M_{\text{no pressure}} = 5.41$, $M_{\text{pressure}} = 5.21$).

For the conventional money-based measure, there was also a significant Time pressure × Valuation strategy interaction for the adjusters, $F(1, 67) = 10.80$, $p = .002$, $r = .37$, ($p = .32$ for the feelers). Fig. 9 shows the residuals representing the pure interaction effect, removing the main effects of time pressure and valuation strategy and the grand mean from participants' mean ratings (Rosenthal & Rosnow, 1991). This figure shows that, when time pressure was applied for the conventional money-based measure, relative use of the adjustment strategy decreased while relative use of the affect-based strategy increased.

For the motivation-based measure, the Time pressure × Valuation strategy interaction was significant for both adjusters and feelers, Fs > 7.34, ps < .009, rs > .36. However, the direction of the interaction was different for each group. For the adjusters, the effect of time pressure for the motivation-based measure was the same as for the conventional money-based measure: when time pressure was applied, relative use of the adjustment strategy decreased, while relative use of the affect-based strategy increased. For the feelers, when time pressure was applied, relative use of the affect-based strategy decreased, while relative use of the adjustment strategy increased.

Relationship between PV and valuation strategy. This increase with time pressure in use of the affect-based strategy relative to the adjustment strategy, for those participants who relied predominantly on adjustment as a valuation strategy, helps to account for the drop in PV that these same participants showed on the conventional money-based measure with time pressure. Recall that greater use of the affect-based strategy corresponded to lower PVs for future rewards (for both the money- and motivation-based measures) in the no pressure condition. Similarly, this relationship between greater use of the affect-based strategy and lower PVs for future rewards was present and significant for the adjusters for the conventional money-based measure, both with and without time pressure: no pressure: $r(67) = -.32$, $p = .009$, pressure: $r(67) = -.37$, $p = .002$). For the motivation-based measure and for the feelers for both the money- and motivation-based measures, the correlations were directionally the same, but most were weaker: rs varied from −.03 to −.38, mean r was −.16.

Also consistent with the no pressure condition, use of the adjustment strategy showed no relationship with the summary PVs for future rewards for either the adjusters or feelers for either the money- or motivation-based measures: rs varied from −.16 to .17, mean r was −.01.

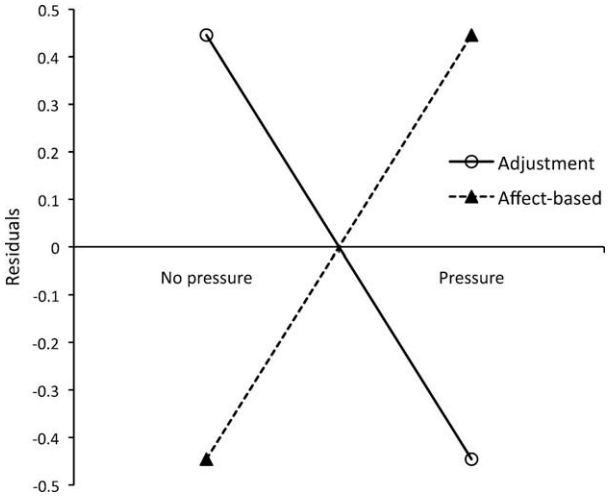

Fig. 9. Mean residuals for Time pressure × Valuation strategy interaction for adjusters on the conventional money-based measure in Study 5.

Other analyses

Correlations between PVs of future rewards for money- and motivation-based measures. In this study, the overall correlations between the summary PVs for the future rewards for the conventional money-based and the motivation-based measure were positive and significant for both the no pressure and pressure conditions (no pressure: $r(100) = .46$, $p < .001$; pressure: $r(100) = .55$, $p < .001$). However, the size of these correlations varied considerably depending on how participants made their valuations. Correlations for participants who used the same predominant strategy on both measures (i.e., they were either adjusters or feelers on both) were higher than for participants who used different strategies on the two measures. Correlations (averaged across the no pressure and pressure conditions) were: $r_{\text{adjusters on both}} = .47$, $r_{\text{feelers on both}} = .54$, $r_{\text{different strategies}} = .19$.

Correlations between summary PVs and measures of future orientation. Finally, I examined whether participants' summary PVs on either the money- or motivation-based measure were predictive of their future orientation, as measured by the Future subscale on the Zimbardo Time perspective measure. Correlations between this measure and participants' summary PVs were very low when calculated across all participants (mean *r*s across no pressure and pressure conditions were: $r_{\text{money-based}} = .06$, $r_{\text{motivation-based}} = .10$). However, correlations were more positive for feelers (mean *r*s were: $r_{\text{money-based}} = .20$, $r_{\text{motivation-based}} = .20$), though the only significant correlation was that for the motivation-based measure PV with no pressure, $r(52) = .29$, $p = .04$. In contrast, correlations between future orientation and PVs for adjusters were close to zero (mean *r*s were: $r_{\text{money-based}} = .05$, $r_{\text{motivation-based}} = -.01$). That is, PVs obtained using the motivation-based measure for people who predominantly use an affect-based valuation strategy were more predictive of individuals' future orientation than were the PVs on the conventional money-based measure.

Discussion

As in all previous studies, the motivation-based PVs for future rewards were lower than the conventional money-based PVs for those rewards for the same participants. These differences in PV also corresponded to differences between the conventional money-based and the motivation-based measures on how participants made their valuations for future rewards. For the conventional money-based measures, on which they showed a higher PV, participants were more likely to use an anchoring-and-adjustment strategy in valuing future rewards, anchoring on the value in the present before adjusting for the delay until receipt of the reward, and less likely to use an affect-based strategy, i.e., imagining how getting the future reward and getting the money they indicated would feel, and trying to match those feelings. They also took more time to make their valuations on the conventional money-based measure, especially for future rewards.

For the motivation-based measure, on which participants had lower PVs, the opposite was found for valuation strategy: participants were less likely to use an anchoring-and-adjustment strategy in valuing future rewards, and more likely to use an affect-based strategy, i.e., imagining how receiving the future reward and listening to the noise for a number of times would feel, and trying to match them. They took less time to make their valuations on the motivation-based measure, and took similar time to value both present and future rewards. Furthermore, the extent to which they used the affect-based strategy (on either measure) predicted their PV for future rewards: the more they used this strategy the lower their PVs.

Using a time pressure manipulation, I succeeded in changing the valuation strategies participants used, with a corresponding change in PVs. Use of both strategies decreased with time pressure, but there was also an interaction with time pressure. In general, if participants' predominant valuation strategy on a measure was anchoring-and-adjustment, they used this strategy less with time pressure (relative to the affect-based strategy). However, if their predominant strategy was affect-based, they showed no change (money-based measure) or used that strategy relatively less (motivation-based measure). In other words, participants dealt with the application of time pressure by changing their valuation strategy, especially if it was the more time-consuming adjustment strategy. This change in valuation strategy resulted in a reliable change in PV only for participants who predominantly used the adjustment strategy on the conventional money-based measure. This perhaps simply reflects a larger effect: for the conventional money-based measure more than two thirds of participants predominantly used the adjustment strategy compared with only a third of participants for the motivation-based measure.

In previous studies, correlations of PVs between the conventional money-based and the motivation-based measures were low (Studies 1a, 1b and 2), or at least lower than correlations of PVs either between conventional money-based measures or between motivation-based measures (Studies 3 and 4), suggesting these measures may assess somewhat different constructs. The current study suggests an explanation for these correlational results based on the strategies that underlie valuation for each measure. In this study, correlations between PVs for the money- and motivation-based measures were low unless people used the same predominant strategy on both valuation measures, in which case the correlations were considerably higher.

Finally, similar to results for other measures of inter-temporal preference in Study 4, an individual's motivation-based PV was a better predictor of his or her future orientation than was the individual's conventional money-based PV.

General discussion

The goals of this research were: (1) to examine whether conventional money-based measures of discounting or PV are accurate measures of the motivational power of the future for present behavior and (2) to explore potential explanations for any observed inconsistency between conventional money- and motivation-based measures of PV. This involved developing several motivation-based measures of PV for comparison with money-based PV measures. Using the financial incentive literature, I identified tasks on which individuals' exerted effort, a marker of motivated behavior (Martin & Tesser, 2009), would vary closely with variation in monetary rewards. For these tasks, I calibrated the value of one or more future monetary rewards against the value of a range of present monetary rewards to estimate a motivation-based PV for the future monetary rewards. Value was measured in precisely the same way for present and future rewards. These motivation-based PVs were compared with money-based PVs for the same future rewards.

The results were consistent across six studies. Money-based PVs were larger than the motivation-based PVs for the same monetary rewards for the same participants. This was found for three different measures of motivation-based PV: actual behavior on a detection task (Studies 1a and 1b), estimated behavior on the same detection task (Studies 2–4), and estimated behavior on an endurance task (Study 5). It was found for money-based PV measures based either on participants' stated equivalent-value (Studies 1a, 1b and 2) or on their stated willingness to invest (Study 3). It was found with varied response methods for valuation, including providing a numerical value (Studies 1a, 1b and 2) and clicking on a visual-analogue scale (Studies 3–5) both with and without

markings (Study 5). It was found when rewards were manipulated within-subjects (Studies 2–5), where participants presumably had more opportunity to "correct" this inconsistency in value. And it was found when the presentation and response methods used were identical for both money- and motivation-based measures of PV (Studies 3–5), that is: when the money-based PV measure used separate assessment of present and future rewards, mimicking the structure of the motivation-based measures of PV, and when the response mode for valuation was identical for both measures.

Money- and motivation-based measures of PV for the same rewards were, in general, discriminant from each other. In Studies 1a, 1b and 2, where there were differences in the methods used for reward presentation and for valuation response across the two measures, the correlations were very low: all .22 or less, often close to zero. In studies, 3, 4 and 5, where the methods used for reward presentation and valuation response were matched across the two measures, this inter-correlation was higher, but the two measures of PV still showed some discriminant validity. Different money-based measures showed higher correlations with each other than with a motivation-based measure (Study 3) and motivation-based measures showed higher correlations with each other than with a money-based measure (Study 4) providing support for the convergent and discriminant validity of both money- and motivation-based measures (Campbell & Fiske, 1959).

Beyond demonstrating the persistence of this difference in PV between money- and motivation-based measures across contexts and after removing differences in presentation and response methods between the measures, I also tested several potential explanations for the difference between PVs. In Study 2, I examined whether the proximity of effort exertion and valuation for the motivation-based measure might account for the difference between money- and motivation-based PVs. Separating in time participants' effort exertion and their valuations had an effect on participants' valuations on the motivation-based measure, but it changed valuations of present and future rewards to a similar extent, resulting in no overall change in PV. Therefore the difference in PV between the money- and motivation-based measures occurred and was of similar magnitude for both effort timing conditions suggesting that the exertion of effort proximal to valuation in the motivation-based measure is unlikely to account for this difference in PV.

Similarly, using an invest version of the money-based measure had an effect on participants' valuations (Study 3), but it changed valuations of present and future rewards to a similar extent, resulting in no overall change in PV. So the difference in PV between the money- and motivation-based measures occurred and was of similar magnitude for both the equivalent-value version and the invest version of the money-based measure suggesting that it is unlikely to be the loss aversion from exerting effort in the motivation-based measure of PV for a future reward that accounts for the difference in PV between money- and motivation-based measures.

These conclusions, that the difference in PV is unlikely to be caused by proximity of effort exertion or loss aversion in the motivation-based measures, both depend on null effects: the lack of an interaction effect on valuation between measure (money- and motivation-based) and time of reward (present and future). So these results do not conclusively prove that these two factors do not contribute to the difference in PV between money- and motivation-based measures. However, the manipulations of these two factors did not fail: each had a main effect on valuation. So, the failure to detect an interaction suggests that any interaction effect is likely to be small and so is unlikely to account for more than a small part of the difference between PVs.

A third explanation tested in Study 5 – that the valuation strategy that participants use when valuing future rewards differs for the conventional money-based and motivation-based measures – does account for at least part of the difference between money- and motivation-based PV. In Study 5, most participants relied on an anchor-and-adjustment strategy for the conventional money-based measure and most participants relied on an affect-based strategy for the motivation-based measure. This latter strategy, where feelings associated with present behavior on a task are directly compared with feelings associated with future rewards, results in lower PVs for future rewards. The valuation strategy participants used also changed when under time pressure, resulting in greater relative use of the affect-based strategy for valuing future rewards on the conventional money-based measure and a corresponding drop in the PVs.

This finding is consistent with previous research looking at valuation of present and future rewards (Ebert, 2001; Ebert & Prelec, 2007), which suggested that people may use an anchor-and-adjustment strategy for the valuation of future rewards. In that research, application of time pressure increased PV for distant future rewards, probably by restricting adjustment for delay or increasing neglect of the future time dimension. Here, the effect of time pressure was to change the valuation strategy that participants used on the conventional money-based measure, so they were more likely to rely on an affect-based strategy, resulting in a lower PV. This was perhaps the natural response in this situation, where many participants had already used an affect-based strategy at least once when completing the measures with no time pressure.

The finding that money- and motivation-based measures dissociate – that is, they result in different PVs for the same rewards and show discriminant validity – fits with previous research that has found dissociation between monetary assessments of value and affect-based assessments of value (Amir et al., 2008; Hsee & Rottenstreich, 2004). In the current studies, correlations between PVs obtained from money- and motivation-based measures increased with identical methods of presentation and response for both measures, but the measures still showed some discriminant validity and the difference in PV remained.

These results suggest that money- and motivation-based measures may assess different separable dimensions or constructs of future rewards, their perceived monetary value and their motivational value, respectively. Consistent with this idea, correlations between the money- and motivation-based measures were considerably higher for those individuals who used the same valuation strategy for both the conventional money-based or motivation-based measures compared to those individuals who used different strategies on the measures (Study 5). That is, those individuals who use the same strategy on both measures are perhaps assessing the same dimension or construct of the future rewards on both measures, i.e., the perceived monetary value or motivational value on both measures.

Certainly the present research establishes that conventional money-based measures provide poor assessments of the motivational value of the future for the present. Crucially, this was the case even though the valuation of present rewards on each type of measure was used to calibrate the money- and motivation-based measures to enable comparison across the measures of PVs for future rewards. And the difference seen consistently across all six studies for the conventional money-based and the motivation-based measures was for PV, i.e., for the *relative* value of future to present rewards. There was not simply a difference across measures on absolute values of rewards. Future rewards are surprisingly low in motivational value for people, such that people exert effort, and estimate they will exert effort, considerably more for *present* rewards that they claim have *exactly the same present value to them as the future rewards have*. This result is perhaps especially interesting given that discount rates for future money that are obtained using conventional money-based measures tend to be quite

high (and PVs low) relative to market interest rates, a benchmark sometimes used by intertemporal researchers (Frederick, Loewenstein, & O'Donoghue, 2002).

Because of the care taken in the development and comparison of these different measures of PV, there are a number of explanations used to explain other inconsistencies in the literature on discounting that *cannot* account for the inconsistency seen here between the conventional money-based and the motivation-based PVs. For example, past research has shown that people use different discount rates for different domains, for different products, for different magnitudes of reward, and for gains versus losses. However, the current results do not simply reflect the use of different discount rates for different quantities of any kind, e.g., different discounting for effort versus money, for different magnitudes, etc. Both the conventional money-based and the motivation-based methods used identical rewards (identical in domain, size, type, time available, and whether they were real or hypothetical) and both measures identified the equivalent present *monetary* value for a future monetary reward. That is, both the money- and motivation-based measures measured discounting of future money relative to present money.

I have argued that discount rates ought to reflect the motivational value of individuals' enduring future concerns relative to their enduring immediate concerns if they are to be useful for predicting people's behavior on average or over the long-run, i.e., when a temporary change in the attraction of short-term considerations does not overwhelm people's longer-term considerations. But this research suggests that discount rates measured using conventional money-based measures do not accurately represent the motivational value of future rewards in the present. Past research has often shown poor correspondence between conventionally-measured discount rates and real behaviors that we expect to be motivated by the future, but are motivation-based measures likely to be more useful in this regard?

The motivation-based measures used here recruited a very limited set of present behaviors: actual or estimated effort exerted on simple tasks for which effort was closely tied to variation in financial incentive. This was deliberate: the primary goal of this research was to examine whether money-based measures of discounting or PV are accurate measures of the motivational power of the future for present behavior. Participants were motivated by the future rewards offered, and effort was used as a marker of motivation. Any other reasons for variation in present behavior were minimized or held constant across experiment conditions (by randomization of participants to condition). These constraints help to ensure internal validity in this research, allowing me to conclude that conventional money-based measures of discounting are inaccurate measures of the motivational value of future rewards.

However, these constraints are also likely to restrict the predictive power of the motivation-based measures for other behaviors that involve motivation by the future. Real behaviors that involve future motivation are commonly complex, determined by future and present concerns, and any connections between them. For example, whether someone chooses to invest the money they receive from a tax return or to buy themselves a vacation is likely to depend on the importance of future concerns ("I want to be sure I have enough savings for when I want to buy a house"), present concerns ("but I could really do with a vacation right now"), and the perceived connection between the present action and the future reward ("if I invest this $700 in my savings account now, how much difference will that make for my savings in 5 years"?). Also, the present research only used monetary rewards. The considerations involved in other kinds of rewards, such as those in other domains, will be different. For example, in considering future health people may feel less certain of the effect of their actions now on the likelihood of achieving the reward in the future ("if I eat a piece of cake instead of an apple now, will that really make any difference to my health 10 years from now"?). As such, multiple measures that relate to all of these considerations are likely to be needed to improve prediction of real behaviors that involve future motivation (see Frederick, Loewenstein, & O'Donoghue, 2002, for a related discussion). For example, in the area of health such additional measures are common, such as measures of the perceived connection between current behavior and future health goals, and they improve prediction of present behavior (Salovey, Rothman, & Rodin, 1998).

Nonetheless, the motivation-based measure may prove to be a more broadly useful measure of temporal discounting than conventional money-based measures, in part because of the strategy people use in valuing future rewards on the motivation-based measure: an affect-based strategy. Affect-based strategies or heuristics are used for making a wide variety of judgments and choices as affective responses to objects are often used as proxies for value (Pham, 2004; Schwarz & Clore, 1996; Slovic, Finucane, Peters, & MacGregor, 2002). This fact alone may broaden the predictive power of motivation-based measures, at least for behaviors and other measures that are largely determined by future concerns.

Related to this, in the current research the motivation-based measures were somewhat more predictive of other measures of inter-temporal preference and temporal orientation (Studies 4 and 5), perhaps reflecting the use of affect-based heuristics or strategies on some of those measures. In particular, in Study 5, the relationships with participants' temporal orientation was more positive for those participants who relied predominantly on a affect-based strategy for either the conventional money-based or motivation-based measures.

Whether or not motivation-based measures have greater predictive power than conventional money-based discounting measures for a wider range of real behaviors that involve consideration of the future is a question for future research. But understanding what measures of discounting do and do not measure can only help us to understand when and why these measures are likely to be useful predictors of behaviors that involve consideration of the future.

Acknowledgments

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References

Alessi, S. M., & Petry, N. M. (2003). Pathological gambling severity is associated with impulsivity in a delay discounting procedure. *Behavioural Processes, 64*, 345–354.

Amir, O., Ariely, D., & Carmon, Z. (2008). The dissociation between monetary assessments and predicted utility. *Marketing Science, 27*(6), 1055–1064.

Baron, J. (2000). Can we use human judgments to determine the discount rate? *Risk Analysis, 20*(6), 861–868.

Baumeister, R. F., & Vohs, K. D. (2003). Willpower. In G. F. Loewenstein, D. Read, & R. F. Baumeister (Eds.), *Time and decision* (pp. 201–216). New York: Russell Sage.

Becker, G. M., DeGroot, M. H., & Marshak, J. (1964). Measuring utility by a single-response sequential method. *Behavioural Science, 9*, 226–232.

Bickel, W. K., Odum, A. L., & Madden, G. J. (1999). Impulsivity and cigarette smoking: Delay discounting in current, never, and ex-smokers. *Psychopharmacology, 146*, 447–454.

Camerer, C. F., & Hogarth, R. M. (1999). The effects of financial incentives in experiments: A review and capital-labor-production framework. *Journal of Risk and Uncertainty, 19*, 7–42.

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait–multimethod matrix. *Psychological Bulletin, 56*, 81–105.

Chapman, G. B. (1996). Temporal discounting and utility for health and money. *Journal of Experimental Psychology: Learning, Memory and Cognition, 22*, 771–791.

Chapman, G. B., Brewer, N. T., Coups, E. J., Brownlee, S., Leventhal, H., & Leventhal, E. A. (2001). Value for the future and preventive health behavior. *Journal of Experimental Psychology: Applied, 7*, 235–250.

Chapman, G. B., & Coups, E. J. (1999). Time preferences and preventive health behavior: Acceptance of the influenza vaccine. *Medical Decision Making, 19*, 307–314.

Chapman, G. B., & Elstein, A. S. (1995). Valuing the future: Temporal discounting of health and money. *Medical Decision Making, 15*, 373–386.

Coller, M., & Williams, M. B. (1999). Eliciting individual discount rates. *Experimental Economics, 2*, 107–127.

Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design and analysis issues for field settings*. Boston: Houghton Mifflin.

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological Bulletin, 52*, 281–302.

Ebert, J. E. J. (2001). The role of cognitive resources in the valuation of near and far future events. *Acta Psychologica, 108*(September), 155–171.

Ebert, J. E. J., & Prelec, D. (2007). The fragility of time: Time-insensitivity and valuation of the near and far future. *Management Science, 53*(9), 1423–1438.

Ekman, G., & Bratfisch, O. (1965). Subjective distance and emotional involvement: A psychological mechanism. *Acta Psychologica, 24*, 430–437.

Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives, 19*(4), 25–42.

Frederick, S., Loewenstein, G. F., & O'Donoghue, T. (2002). Time discounting and time preference: A critical review. *Journal of Economic Literature, 40*, 351–374.

Fuchs, V. R. (1982). Time preference and health: An exploratory study. In V. R. Fuchs (Ed.), *Economic aspects of health*. Chicago: University of Chicago Press.

Gately, D. (1980). Individual discount rates and the purchase and utilization of energy-using durables: Comment. *Bell Journal of Economics, 11*, 373–374.

Gilbert, D. T. (2002). Inferential correction. In T. Gilovich, D. W. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 167–184). Cambridge, UK: Cambridge University Press.

Gilbert, D. T., & Ebert, J. E. J. (2002). Decisions and revisions: The affective forecasting of changeable outcomes. *Journal of Personality and Social Psychology, 82*, 503–514.

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of delayed rewards: A life-span comparison. *Psychological Science, 5*(1), 33–36.

Green, L., Myerson, J., & McFadden, E. (1997). Rate of temporal discounting decreases with amount of reward. *Memory and Cognition, 25*(5), 715–723.

Gyrd-Hansen, D., & Søgaard, J. (1998). Discounting life-years: Whither time preference? *Health Economics, 7*, 121–127.

Hausman, J. (1979). Individual discount rates and the purchase and utilization of energy-using durables. *Bell Journal of Economics, 10*, 33–54.

Hsee, C. K. (1999). Value seeking and prediction–decision inconsistency: Why don't people take what they predict they'll like the most? *Psychonomic Bulletin and Review, 6*(4), 555–561.

Hsee, C. K., & Rottenstreich, Y. (2004). Music, pandas, and muggers: On the affective psychology of value. *Journal of Experimental Psychology: General, 133*(1), 23–30.

Jenkins, G. D., Jr., Mitra, A., Gupta, N., & Shaw, J. D. (1998). Are financial incentives related to performance? A meta-analytic review of empirical research. *Journal of Applied Psychology, 83*, 777–787.

Kahneman, D. (2003). Experiences of collaborative research. *American Psychologist, 58*, 723–730.

Kassam, K. S., Gilbert, D. T., Boston, A., & Wilson, T. D. (2008). Future anhedonia and time discounting. *Journal of Experimental Social Psychology, 44*, 1533–1537.

Kerner, D. A., Driver-Linn, Erin, Wilson, Timothy D., & Gilbert, Timothy D. (2006). Loss aversion is an affective forecasting error. *Psychological Science, 17*(8), 649–653.

Kirby, K. (1997). Bidding on the future: Evidence against normative discounting of delayed rewards. *Journal of Experimental Psychology: General, 126*(1), 54–70.

Kirby, K., Petry, N. M., & Bickel, W. K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General, 128*, 78–87.

Liberman, N., & Trope, Y. (1998). The role of feasibility and desirability considerations in near and distant future decisions: A test of temporal construal theory. *Journal of Personality and Social Psychology, 75*(July), 5–18.

Liu, W., & Aaker, J. L. (2007). Do you look to the future or focus on today? The impact of life experience on intertemporal decisions. *Organizational Behavior and Human Decision Processes, 102*, 212–225.

Martin, L. L., & Tesser, A. (2009). Five markers of motivated behavior. In G. B. Moskovitz, & H. Grant (Eds.), *The psychology of goals* (pp. 257–276). New York: Guilford.

Mischel, W., Ayduk, O., & Mendoza-Denton, R. (2003). Sustaining delay of gratification over time: a hot-cool systems perspective. In G. F. Loewenstein, D. Read, & R. F. Baumeister (Eds.), *Time and decision* (pp. 175–200). New York: Russell Sage.

Ostszewski, P. (1996). The relation between temperament and rate of temporal discounting. *European Journal of Personality, 10*, 161–172.

Pham, M. T. (2004). The logic of feeling. *Journal of Consumer Psychology, 14*, 360–369.

Pham, M. T. (2007). Emotion and rationality: A critical review and interpretation of empirical evidence. *Review of General Psychology, 11*(2), 155–178.

Read, D., & Van Leeuwen, B. (1998). Predicting hunger: The effects of appetite and delay on choice. *Organizational Behavior and Human Decision Processes, 76*(2), 189–205.

Rosenthal, R., & Rosnow, R. L. (1991). *Essentials of behavioral research: Methods and data analysis* (2nd ed.). New York: McGraw-Hill.

Salovey, P., Rothman, A. J., & Rodin, J. (1998). Health behavior. In D. T. Gilbert, S. T. Fiske, & L. Gardner (Eds.), *The handbook of social psychology* (4th ed., pp. 633–683). New York, NY: Oxford University Press.

Schelling, T. C. (2000). Intergenerational and international discounting. *Risk Analysis, 20*(6), 833–837.

Schwarz, N., & Clore, G. L. (1996). Feelings and phenomenal experiences. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 433–465). New York: Guilford Press.

Slovic, P., Finucane, M., Peters, E., & MacGregor, D. G. (2002). The affect heuristic. In T. Gilovich, D. W. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 397–420). New York: Cambridge University Press.

Sultan, F., & Winer, R. S. (1993). Time preferences for products and attributes and the adoption of technology-driven consumer durable innovations. *Journal of Economic Psychology, 14*, 587–613.

Thaler, R. H. (1981). Some empirical evidence on dynamic inconsistency. *Economic Letters, 8*, 201–207.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124–1131.

Vuchinich, R. E., & Simpson, C. A. (1998). Hyperbolic temporal discounting in social drinkers and problem drinkers. *Experimental and Clinical Psychopharmacology, 6*, 292–305.

Wright, R. A., & Brehm, J. W. (1989). Energization and goal attractiveness. In I. A. Irvin (Ed.), *Goal concepts in personality and social psychology* (pp. 169–210). Hillsdale, NJ: Erlbaum.

Zimbardo, P. G., & Boyd, J. N. (1999). Putting time in perspective: A valid, reliable individual-differences metric. *Journal of Personality and Social Psychology, 77*, 1271–1288.