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Good or Bad, We Want it Now: Fixed-cost Present Bias for Gains *and* Losses Explains Magnitude Asymmetries in Intertemporal Choice

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ABSTRACT

Intertemporal tradeoffs are ubiquitous in decision making, yet preferences for current versus future *losses* are rarely explored in empirical research. Whereas rational-economic theory posits that neither outcome sign (gains vs. losses) nor outcome magnitude (small vs. large) should affect delay discount rates, both do, and moreover, they interact: in three studies, we show that whereas large gains are discounted less than small gains, large losses are discounted more than small losses. This interaction can be understood through a reconceptualization of fixed-cost present bias, which has traditionally described a psychological preference for immediate rewards. First, our results establish present bias for losses—a psychological preference to have losses over with now. Present bias thus predicts increased discounting of future gains but decreased (or even negative) discounting of future losses. Second, because present bias preferences do not scale with the magnitude of possible gains or losses, they play a larger role, relative to other motivations for discounting, for small magnitude intertemporal decisions than for large magnitude intertemporal decisions. Present bias thus predicts less discounting of large gains than small gains but more discounting of large losses than small losses. The present research is the first to demonstrate that the effect of outcome magnitude on discount rates may be opposite for gains and losses and also the first to offer a theory (an extension of present bias) and process data to explain this interaction. The results suggest that policy efforts to encourage future-oriented choices should frame outcomes as large gains or small losses. Copyright © 2012 John Wiley & Sons, Ltd.

Supporting information may be found in the online version of this article.

KEY WORDS temporal discounting; delay; time preference; impatience; dread

Whether racking up credit card debt, eating unhealthy foods, or acting in environmentally destructive ways, consumers often discount future consequences, wanting to have gains immediately and to postpone losses until later. In general, the farther into the future that an outcome is delayed, the more it is discounted.[1] There are a number of factors hypothesized to contribute to the discounting of future gains (for overviews, see Frederick, Loewenstein, & O'Donoghue, 2002; Hardisty, Orlove, *et al*., 2012). A reason often noted by economists is opportunity cost: one could take the immediate $100, invest it, and have more than $110 in a year's time (Franklin, 1748; Samuelson, 1937). A second reason to discount the future is uncertainty (Bixter & Luhmann, 2011; Patak & Reynolds, 2007; Takahashi, Ikeda, & Hasegawa, 2007). For example, if offered a choice between getting $100 now or $110 in a year, one may value the $100 more because it is a sure thing, whereas the future is inherently uncertain: a promised check may never arrive, hyperinflation could render the money worthless, or one might die before having the chance to spend it. A third reason is resource slack (Zauberman & Lynch, 2005): most people believe that although money is tight right now, they will have more resources in the future, so it is more useful to have the money immediately rather than later. A fourth reason to discount the future is present bias (Benhabib, Bisin, & Schotter, 2010; Laibson, 1997; O'Donoghue & Rabin, 1999): people are impatient and simply *want* to have gains immediately, above and beyond any material reasons.

One well-established empirical observation about discounting is the so-called "magnitude effect:" people discount *small* gains at a higher rate than *large* gains (Baker, Johnson, & Bickel, 2003; Benhabib *et al*., 2010; Chapman, 1996; Chapman & Elstein, 1995; Estle, Green, Myerson, & Holt, 2006; Giordano *et al*., 2002; Green, Myerson, & McFadden, 1997; Kirby & Marakovic, 1995; Kirby & Marakovic, 1996; Petry, 2001; Raineri & Rachlin, 1993; Thaler, 1981). For example, someone might choose $10 today versus $11 in a year, yet prefer to wait for $11 000 in a year rather than take an immediate $10 000, even though in both cases the later amount is 10% larger than the sooner amount. Although several models of intertemporal choice can mathematically describe this pattern of behavior through various value functions (al-Nowaihi & Dhami, 2009; Loewenstein & Prelec, 1992; Scholten & Read, 2010), they are silent on the psychological process that underlies the magnitude effect. A notable exception is the theory of fixed-cost present bias.

According to the theory of fixed-cost present bias (Benhabib *et al*., 2010), people are impatient, desiring to have good things right away. Satisfying this present bias appears to be worth about $4 to people, regardless of the size of the outcome under

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[1]Throughout the manuscript, we use the terms "time preference" and "discounting" to refer to the overall preference for when something may occur or how much something is worth at a given delay, respectively. Therefore, observed time preferences and discount rates are the end result of multiple factors. We will not address the highly specific "pure time preference" for utility that is sometimes indicated in economic papers by the use of the terms "time preference" and "discounting." As noted by Read (2004) and others, the measurement of pure time preference relies on a number of key assumptions that are routinely violated in experimental investigations.

consideration. As a consequence, people's impatience weighs much more heavily (in relative terms) when outcomes are small than when outcomes are large; in the context of $10 now versus $11 in a month, $4 worth of impatience is a lot, but in the context of $10 000 now versus $11 000 in a month, $4 worth of impatience is not very important. Note that this differs from the popular quasi-hyperbolic (a.k.a. "beta/delta") discounting model (Laibson, 1997), in which the present-biased "beta" term scales with amount, explaining temporally myopic preference reversals but *not* the magnitude effect.

None of the existing models of intertemporal choice, however, accurately predict or explain people's time preferences for small versus large *losses*, as detailed in the following discussions. Note that for negative events a large discount rate corresponds to a desire to postpone the event, in contrast to positive events, where a large discount rate indicates a desire to have the event as soon as possible. The vast majority of studies of intertemporal choice have focused exclusively on current versus future gains. However, many intertemporal choices involve losses, for example, the choice between buying a more fuel-efficient car with a large(r) purchase price now versus paying more at the gas pump down the road for a cheaper but less fuel-efficient car.

The effect of magnitude on discount rates for losses

A small number of studies suggest that the magnitude effect may not exist for losses (Baker *et al*., 2003; Estle *et al*., 2006). Participants in one study showed similar discount rates for $100 losses as for $100 000 losses (Estle *et al*., 2006), and participants in another study showed almost no difference in discount rates between losses of $10, $100, and $1000 (Baker *et al*., 2003).[2] The choice options in these studies always paired a smaller, sooner amount with a larger, later amount, so it was impossible for participants to express zero or negative discount rates. Thus, although some people might rather pay $10 immediately rather than $9 in a year (to get the loss over with), this preference could never be expressed in the experiment, and the distribution of discount rates may therefore have been truncated.

A recent study by Mitchell and Wilson (2010), which allowed for slightly negative discount rates (one choice pair was between losing $10.50 today or $10 in the future), found a non-significant trend for a *reverse* magnitude effect, whereby small losses were discounted less than large losses ~~(Figure 1)~~. A pilot study we ran found similar results: an online sample with 50 usable responses made hypothetical choices between immediate and future gains and losses in the $10 or $1000 range. As seen in Figure 1, sign and magnitude interacted to determine discount rates, $F(1,48) = 11.5$, $p = .001$, $\eta^2 = .19$: whereas large gains were discounted less than small gains, there was a non-significant trend for losses to show the reverse pattern. In concrete terms, participants considering small gains were indifferent on average between receiving $10 today and $16 in 6 months, whereas participants considering large gains were indifferent between receiving $1000 today and $1210 in 6 months. In contrast, participants considering small losses were indifferent between paying $10 today and $9.70 in 6 months, whereas those considering large losses were indifferent between paying $1000 today and $1070 in 6 months. Notably, zero discounting and negative discounting were quite common in the *small loss* condition but were fairly rare in the other conditions. Specifically, when faced with a choice between paying $10 immediately or $10 in 6 months, 50% of participants chose to pay immediately (quite similar to the 45% reported in the Mitchel and Wilson paper). Zero and negative discount rates have been documented for electric shocks (Yates & Watts, 1975), health maladies (Chapman, 1996; Hardisty & Weber, 2009), and other dreadful events (Harris, 2010). The results of our pilot and the Mitchell and Wilson (2010) study suggest that they are common for small financial losses as well.

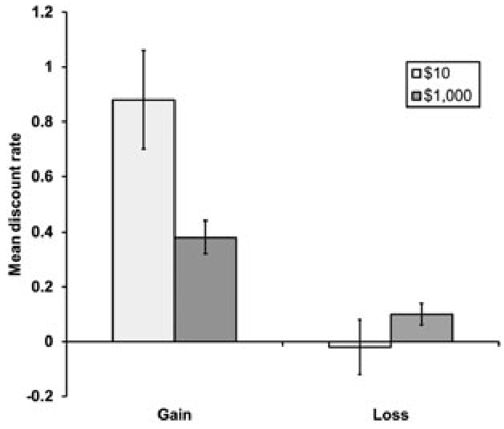

Figure 1. Mean discount rates (k) per year for small and large gains and losses, in the pilot study. Error bars show ±one standard error

Explaining the sign by magnitude interaction

Even among those mathematical models of intertemporal choice that capture the magnitude effect and the sign effect (e.g., al-Nowaihi & Dhami, 2009; Loewenstein & Prelec, 1992; Scholten & Read, 2010), none predict the sign by magnitude interaction. Rather, they all predict equivalent effects of magnitude on discount rates for gains and losses. Neither can the theory of fixed-cost present bias explain these findings. Fixed-cost present bias theory predicts that people put a premium (of roughly $4) on having gains now and a premium (again of roughly $4) on postponing losses. For example, when people consider *losing* $10 immediately or $12 in 1 month, fixed-cost present bias predicts people will choose the future $12 loss; it is worth $4 to the participant to postpone bad things, and the cost of waiting is only $2. In

[2]Thaler (1981) also investigated discount rates for intertemporal losses of different sizes, but the results were not conclusive. He reports median discount rates of 26% for $15 losses, compared with 1% for $250 losses, thus demonstrating the same magnitude effect that is typically seen with gains. However, the sample size was small ("about twenty usable responses", p. 203), and no measures of variability or statistical significance were reported (except to note that "there was wide variation among subjects", p. 203), so this trend may not reliable. Perhaps more importantly, Thaler (1981) elicited intertemporal indifference points using the matching method (i.e., "fill-in-the-blank"), which has been found to frequently confuse participants in the domain of losses, sometimes yielding data that are opposite of what participants intend to convey (Hardisty, Thompson, Krantz, & Weber, 2012).

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Table 1. Summary of major factors hypothesized to determine intertemporal choices for gains and losses

Motivational factor	Description	Makes people prefer to have...	Scales with magnitude?
Opportunity cost and investment	Resources can be invested and earn interest or otherwise grow over time	Gains now and losses later	Yes
Uncertainty	Delayed gains and losses may never be realized	Gains now and losses later	Yes
Resource slack	Expecting to have more resources in the future means that immediate resources are more dear than future resources	Gains now and losses later	Yes
Present bias	Psychological desire to resolve events immediately	Both gains and losses now	No
Other factors, such as social norms and ideals	Variable, but often suggest that individuals ought to delay gratification	Variable, but often postponing gains and attending to losses immediately	Variable

contrast, when choosing between losing $1000 or $1200 in 1 month, the same participant would be predicted to choose the immediate $1000, because the additional $200 lost from waiting is much greater than the $4 premium the participants puts on immediate welfare. In this way, the theory of Benhabib *et al*. predicts an equal magnitude effect for gains and losses. In both cases, it predicts lower discounting for larger amounts.

To understand the sign by magnitude interaction, we propose a reconceptualization of the fixed-cost present bias theory. Rather than assuming that present bias leads people to want their gains now and their losses later, we propose that people have a psychological desire to resolve both gains *and* losses immediately and that this desire is combined with multiple other factors (such as uncertainty) to ultimately predict time preference. In the case of gains, people want the gain immediately to satisfy their desire for positive outcomes and to avoid feelings of deprivation while waiting (Hoch & Loewenstein, 1991). When combined with other factors (such as those listed in Table 1), the resulting discount rate is high. For example, receiving the money now avoids the risk that a future gain will never arrive, ~~and~~ it can be put in the bank immediately to earn interest, and it may be more useful now while resources are tight. When combined with the psychological desire for immediate gains, the resulting discount rate is quite high. In the case of losses, people want to get the loss over with immediately to close their mental books on the loss and avoid having to allocate attention and emotional capacity (e.g., dread) to looming future losses (Harris, 2010; Loewenstein, 1987).[3] However, this psychological desire is balanced against other factors (Table 1), ultimately resulting in a low discount rate. For example, someone may postpone a bill so that he or she can earn interest on his or her assets in the meantime, or he or she may believe that it will be easier to pay the bill in the future, or he or she may believe that if he or she postpones the loss, he or she may never have to deal with it. Although these factors favor postponing the loss, the psychological desire to get the loss over with favors resolving the loss immediately, and the resulting discount rate is low. In both the case of gains and the case of losses, we posit that this present bias is relatively insensitive to magnitude; it is a constant that is added to other attractions of the immediate reward, rather than a parameter that multiplies the immediate reward's utility (an assumption made and supported by Benhabib *et al*., 2010, for the domain of gains). To explain further: as we consider when to receive or pay an amount, regardless of size, we have a desire to resolve the event immediately if possible. On a psychological level, we would like to have the gain now, and we would like to get the loss over with now. If the gain or loss is a small amount, such as $10, our desire to satisfy impatience or to avoid dread is a relatively important factor. If the gain or loss is a large amount, such as $10 000, we still have the psychological desire to resolve the event as soon as possible, but our desire to satisfy impatience or to avoid dread is *relatively* unimportant compared with other factors—because $10 000 is much money, factors such as uncertainty and resource slack become more important considerations. See Table 1 for a summary of this idea. Thus, for gains, we make identical predictions as Benhabib and colleagues (2010); however, we make different predictions for losses.

Importantly, our theory makes the prediction that *negative* discounting of losses should occur when amounts are small enough, because the cost of waiting is a constant that is added to the disutility of the larger later loss. Negative discounting implies that outcome values intensify (i.e., positives become more positive and negatives become more negative) the further they lie in the future; in the case of losses, negative discounting means a preference to have losses sooner rather than later. For example, some people might rather pay $10 immediately rather than $9 in a year to satisfy their desire to get the loss over with. In this case, a full *reversal* of the magnitude effect when comparing small and large losses is understandable.

In our first study therefore, we tested our prediction with a large, national sample by presenting participants with choices between immediate and future gains and losses that were either small (around $10) or large (around $10 000). As in our pilot study, we included choice options that allowed for negative discount rates, such as a choice between losing

[3]In contrast to Loewenstein's (1987) model of savoring and dread, which posits that people derive positive utility from anticipating gains and negative utility from anticipating losses, our theory contends that, on balance, people derive negative utility from anticipating both gains (because of impatience) and losses (because of dread). Another difference is that while Loewenstein's model specifies that psychological anticipation utility is proportional to outcome magnitude, our theory contends that present bias is relatively insensitive to magnitude.

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$10 immediately or $9 in the future. We predicted that whereas small gains would be discounted more than large gains, showing the usual magnitude effect, small losses would be discounted *less* than large losses, showing a reverse magnitude effect. We also expected losses to be discounted less than gains overall, for the reasons mentioned earlier and summarized in Table 1, as in previous studies on discount rates for gains and losses (Appelt, Hardisty, & Weber, 2011; Hardisty & Weber, 2009; Thaler, 1981).

Furthermore, we wanted to test our theory that this reversal is driven by people's desire to resolve events immediately. To do this, we asked participants to list their thoughts about the intertemporal choice scenario, before they made any choices, using an established "type aloud" protocol (Weber *et al.*, 2007). After they had made their choices, we presented participants' own thoughts back to them and asked them to code the content of each thought. As summarized in Table 1, we predicted that concerns about uncertainty and resource slack would grow more important for larger amounts, and therefore that mentions of wanting to have the gain or loss immediately for other, psychological reasons (i.e., present bias) would be proportionally less common at larger magnitudes. In other words, fixed-cost present bias would not scale up with larger magnitudes and so would become proportionally less influential. We predicted that the relative frequency of these present-biased thoughts would mediate the effect of magnitude on discount rates, in opposite directions for gains and losses. Specifically, we predicted that present bias would make participants desire to resolve gains and losses immediately, which results in greater discount rates for gains and lower discount rates for losses. With increased magnitude, the influence of present bias is reduced, which changes discount rates accordingly.

Subsequently, Studies 2 and 3 replicate and extend our results, rule out some potential confounds, and explore the effects of sign and magnitude across a range of scales and choice options.

STUDY 1

Method

A sample of 224 US residents (mean age = 37, *SD* = 12, 76% female) was recruited from the Virtual Lab subject pool of the Center for Decision Sciences and run online for a study about decision making. Participants were compensated $8 for completing this study and two unrelated studies. In a 2×2 between-subjects design, participants were randomly assigned to one of four conditions: small gain, large gain, small loss, or large loss. We ran this as a between-subjects design for two reasons. One was to maximize the asymmetries in discounting observed in our pilot study between small and large gains and losses to see if the reversal of the magnitude effect would be replicated. (In a within-subjects design, participants often strive for consistency, which reduces framing effects.) The second reason was that the quality and quantity of thought listings often go down sharply after the first scenario for which participants provide such thought listings.

Participants first received training with the computerized "type aloud" interface, in which participants entered one thought at a time. Participants in the small [large] gain conditions then read the following passage:

> Imagine there was a legitimate error on your back taxes in your favor, and you will immediately **receive** $10 [$10 000] from the government. However, they are also giving you the option of receiving a different amount one year from now, instead. How much would the future amount need to be for you to choose it? The amount you would receive today is **$10 [$10 000]**. The amount you would receive in the future ranges from $9 [$9000] to $35 [$35 000]. We will ask you several questions about whether you would prefer to get $10 [$10 000] today or another amount one year from today.

Participants in the small [large] loss conditions read:

> Imagine there was a legitimate error on your back taxes against you, and you must **pay** the government $10 [$10 000] immediately. However, they are also giving you the option of paying a different amount one year from now, instead. How much would the future amount need to be for you to choose it? The amount you would pay today is **$10 [$10 000]**. The amount you would pay in the future ranges from $9 [$9000] to $35 [$35 000]. We will ask you several questions about whether you would prefer to pay $10 [$10 000] today or another amount one year from today.

All participants then listed their thoughts about the scenario, following the instruction:

> Before you indicate your preference for these choices, please tell us everything you are thinking of as you consider this decision between receiving [paying] $10 [$10 000] today or receiving [paying] a potentially larger amount in one year. We would like you to list any thoughts, positive or negative, that you might have. Please enter your thoughts one at a time. Please type your thought in the box below and, as soon as you are done, hit the "**Enter**" key to submit your thought.

Subsequently, participants made a series of 10 choices between a fixed immediate amount and a varying later amount. The immediate amount was always $10 [$10 000], and the future amount ranged from $9 [$9000] to $35 [$35 000]. The future amount was always 1 year in the future. For the complete list of choices, please see Supporting Information A, online. Hypothetical outcomes were used out of necessity, because it was impossible to execute real $35 000 losses with participants. Fortunately, several recent studies have shown that hypothetical financial intertemporal choice outcomes yield the same results as real outcomes (Bickel, Pitcock, Yi, & Angtuaco, 2009; Johnson & Bickel, 2002) and that hypothetical outcomes predict real-world outcomes of interest such as smoking, body mass index, infidelity, and voucher redemption, (Bickel *et al.*, 2010; Chabris, Laibson, Morris, Schuldt, & Taubinsky, 2008; Reimers, Maylor, Stewart, & Chater, 2009; Shamosh *et al.*, 2008).

After reporting their choices, participants were presented with the thoughts they had listed earlier, one at a time, and

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asked to code each thought as to whether the primary topic of the thought was "Earning interest on investments" (i.e., opportunity cost), "Future uncertainty" (i.e., uncertainty), "Expecting the money will be more useful now than in the future" (i.e., resource slack), "Other: what you want (for example, 'I want it now to get it over with')" (i.e., present bias), "Other: what you ought to do (for example, 'I should wait')" (i.e., social norms), or "None of the above." These categories correspond to the factors presented in Table 1. Participants also coded whether the thought favored choosing the immediate option, the future option, or neither.[4] Finally, participants answered demographic questions.

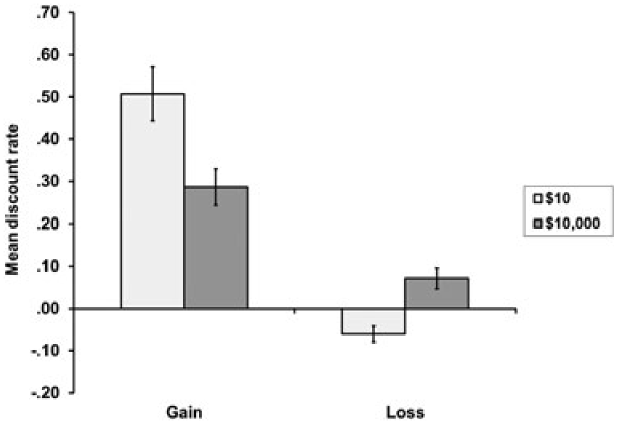

Figure 2. Mean discount rates (k) per year for small and large gains and losses, in Study 1. Error bars show ±one standard error

Results

The data from 25 participants were excluded because of careless responding, as determined by any one of the following three criteria: switching back and forth on the intertemporal choice scale more than once (i.e., non-monotonic responding), perversely switching on the intertemporal choice scale (for example, choosing to receive $12 in 1 year rather than $10 today, and subsequently choosing $10 today rather than $14 in 1 year), or completing the study more than two standard deviations faster than the average natural log of completion time. This left data from 199 participants for further analysis.

Participants' responses were converted into intertemporal indifference pairs by taking the average of the values around the switch point. For example, if a participant chose to receive $10 today over $12 in 1 year and chose $14 in 1 year over $10 today, then the participant was judged to be indifferent between receiving $10 today and $13 in 1 year. To easily compare discounting across magnitudes, indifference between choice options was converted into a discount rate by using the continuously compounded exponential formula $V = Ae^{-kD}$ (Samuelson, 1937), where V is the immediately available amount (e.g., $10), A is the future amount (e.g., $13), e is the constant (2.718), D is the delay (typically in years), and k is a fitted parameter, the discount rate. We chose this equation (rather than the hyperbolic model or the area-under-the-curve method) because it is easily interpretable. For example, a k of .6 per year indicates that future outcomes are discounted at a rate of 60% per year (just like an interest rate, but in reverse). Higher numbers indicate greater discounting, a k of zero means no discounting, and negative k values indicate negative discounting. As choices in this study all involved the same two time points (immediate outcomes vs. outcomes in 1 year), exponential and hyperbolic modeling would fit the data equally well, so there was no advantage to using the hyperbolic model (which is known to generally describe data better than the exponential model, Kirby, 1997; Kirby & Marakovic, 1995; Mazur, 1987).

As summarized in Figure 2, participants' discount rates depended both on the sign and magnitude of the outcome, replicating the results of our pilot study. Although participants discounted small gains (mean $k = 0.51$, $SD = 0.45$) more than large gains ($M = .29$, $SD = .31$), they discounted small losses ($M = -.06$, $SD = .14$) *less* than large losses ($M = .07$, $SD = .17$). This was confirmed with a 2 × 2 ANOVA using sign and magnitude to predict discount rates, which revealed a main effect of sign ($F(1,195) = 86.4$, $p < .001$, $\eta^2 = .31$) and a sign by magnitude interaction ($F(1,195) = 17.5$, $p < .001$, $\eta^2 = .08$) but no evidence for a main effect of magnitude ($F(1,195) = 1.1$, $p = .29$, $\eta^2 = .01$). Pairwise comparisons within each sign between small and large outcomes confirmed the magnitude effect for gains, $t(101) = 2.9$, $p = .004$, $d = .58$, and the reverse magnitude effect for losses, $t(94) = 4.2$, $p < .001$, $d = .87$.

In dollar terms, participants were on average indifferent between receiving $10 immediately and $16.60 in 1 year (when considering small gains) but $10 000 immediately and $13 310 (when considering large gains). In contrasts, participants were indifferent between losing $10 immediately and $9.42 in 1 year (when considering small losses) but $10 000 immediately and $10 740 in 1 year (when considering large losses). As in the pilot study, zero and negative discount rates were quite common when considering small losses, with 78% of participants expressing this preference. In contrast, only 23% of those considering large losses, 2% of those considering small gains, and 2% of those considering large gains showed zero or negative discount rates (all paired comparisons significantly different at $p < .01$ with the exception of small versus large gains). The tendency to postpone rewards has been referred to in the literature as either hyperopia (Kivetz & Keinan, 2006; Kivetz & Simonson, 2002) or future bias (Shu, 2008; Shu & Gneezy, 2010).

Prior to making their choices, participants listed an average of 3.4 thoughts ($SD = 2$). Participants considering large magnitude outcomes listed .6 more thoughts than participants considering small magnitude outcomes, $t(197) = 2.1$, $p = .04$, $d = .30$. This is consistent with the theory that most intertemporal motivations grow more pressing with larger magnitudes. Participants listed .3 more thoughts for gains than losses, but this difference was not significant, $t(197) = 1.1$, $p = .27$, $d = .16$, nor was there an interaction, $F(1,195) = .00$, $p = .85$, $\eta^2 = .00$. The number of thoughts coded as falling into the different types of thought categories described previously differed depending on whether the intertemporal choice

[4]Previous research has established that these self-codings correlate with the codings of blind raters, average $r = .88$ (Weber *et al.*, 2007).

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considered was between small or large gains or losses. We used the proportion of thoughts a decision maker classified as both "Other: what you want (for example, 'I want it now to get it over with')" *and* as favoring the immediate option as a measure of the relative prevalence of present-biased thoughts. An example of a present-biased thought provided by one participant was, "I like to manage situations that arise in my life as quickly as I can, regardless of the conditions/content." Examples of thoughts listed by participants in all categories are provided in Table 2.

As predicted, the proportion of present-biased thoughts was significantly lower for large magnitude outcomes than for small magnitude outcomes (Figure 3). In other words, when participants considered \$10, they frequently mentioned their impatience (to get the money immediately or get the loss over with immediately), whereas when participants considered \$10 000, other concerns were more prominent. A 2×2 ANOVA with sign and magnitude predicting proportion of present-biased thoughts found significant main effects of magnitude, $F(1,195) = 8.3$, $p = .004$, $\eta^2 = .04$; and sign, $F(1,195) = 14.9$, $p < .001$, $\eta^2 = .07$; but not an interaction, $F(1,195) = .88$, $p = .35$, $\eta^2 = .01$. The main effect of sign, showing that present-biased thoughts are more prominent for losses than gains, was not predicted but is consistent with recent findings that the desire to avoid dread of future losses is quite common and powerful (Appelt *et al.*, 2011; Hardisty, Frederick, & Weber, 2012; Harris, 2010).

In contrast to the pattern seen in Figure 3, the proportion of concerns about future uncertainty and resource slack grew larger with larger magnitude outcomes, as predicted (see Table 3 for a summary of the proportion of thoughts in each category and experimental condition). For example, when participants considered \$10 000, they were relatively more worried about future uncertainty than when they considered only \$10. A 2×2 ANOVA with sign and magnitude predicting proportion of thoughts about future uncertainty found a main effect of magnitude, $F(1,195) = 3.8$, $p = .05$, $\eta^2 = .02$, a non-significant a main effect of sign, $F(1,195) = 2.0$, $p = .16$, $\eta^2 = .01$, and no evidence of an interaction, $F(1,195) = .1$, $p = .80$, $\eta^2 = .00$. An ANOVA with sign and magnitude predicting the proportion of thoughts about resource slack found a non-significant main effect of magnitude, $F(1,195) = 2.0$, $p = .16$, $\eta^2 = .01$, which was directionally consistent with our hypothesis but was quite weak. Although not predicted, a main effect of sign predicting resource slack thoughts was significant, $F(1,195) = 10.2$, $p = .002$, $\eta^2 = .05$. This indicates that participants may readily consider how gains may be more useful now than in the future but do not as often consider how losses may be easier to deal with now than later. There was no evidence for an interaction of sign and magnitude predicting resource slack thoughts, $F(1,195) = .1$, $p = .77$, $\eta^2 = .00$ ~~(Figures 4 and 5)~~.

In examining the proportion of thoughts about earning interest, social norms, and other things, no significant effects of magnitude or interactions were found (all $p > .2$). This was surprising, because we had predicted that thoughts about earning interest on investment would be more salient and

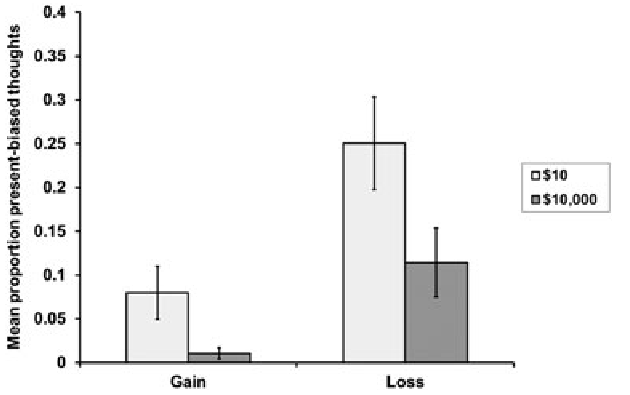

Figure 3. Mean proportion of present-biased thoughts, depending on the sign and magnitude of the outcomes, in Study 1. Error bars show ±one standard error

Table 3. Summary of proportion of thoughts listed by participants for intertemporal choice involving gains and losses of different sizes, in Study 1

Motivational factor	\$10 gain	\$10 000 gain	\$10 loss	\$10 000 loss
Investment interest	.29	.19	.12	.12
Uncertainty	.19	.29	.27	.34
Resource slack	.17	.24	.07	.11
Present bias	.08	.01	.25	.11
Oughts	.09	.09	.06	.14
Other	.18	.18	.23	.17

Table 2. Examples of thoughts listed by participants in each category in Study 1

Motivational factor	Gain example	Loss example
Investment interest	"I could deposit the money into an interest bearing account today and start earning money on it that would be comparable to what I would get by waiting."	"will defer if penalty is equal or lower than current financing possibilities"
Uncertainty	"Laws change, my money could disappear."	"I don't know what the future holds"
Resource slack	"I could really use the money now"	"Waiting a year would give me more time to collect the money and/or find a good loan"
Present bias	"the instant gratification of getting that much money now is certainly tempting "	"I like to pay things off and be done with it."
Oughts	"Patience is a virtue. May as well hold out for the higher amount."	"I feel that it's irresponsible to ignore or neglect your fiscal obligations."
Other	"Hey, \$10 000 extra bucks—that's EXCELLENT!"	"Find a better tax preparer"

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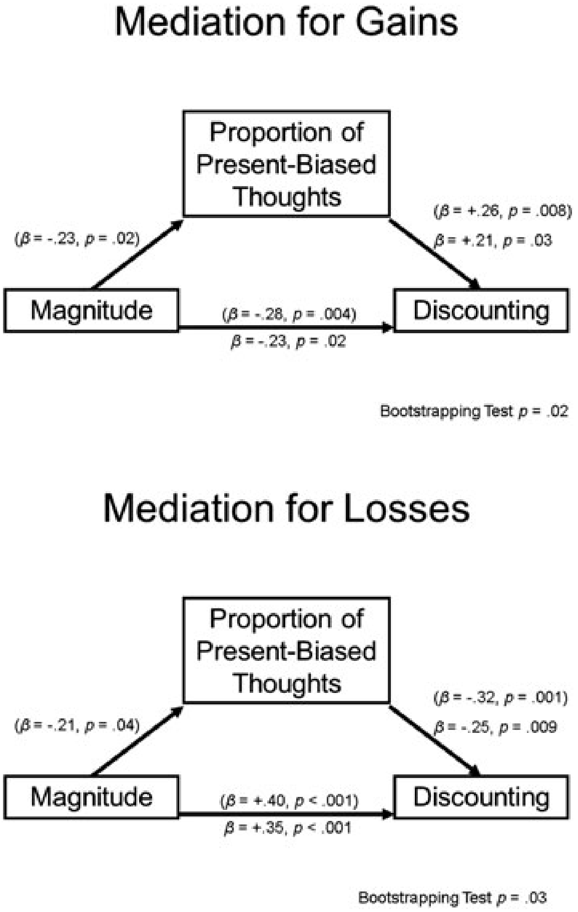

Figure 4. Mediation diagrams showing magnitude having an effect on discount rates through present-biased thoughts, separately for gains and losses, in Study 1. βs show standardized betas. Direct relationships are in parentheses. Note that the relationship between present-biased thoughts and discounting is positive for gains but negative for losses

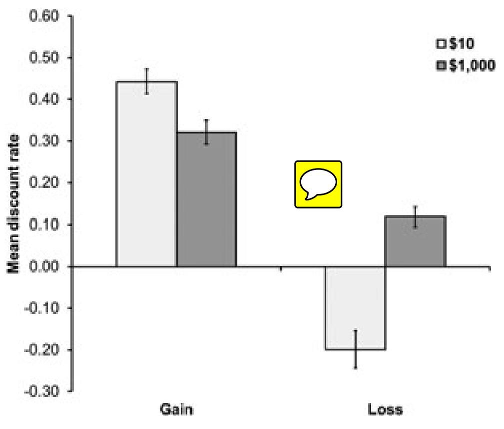

Figure 5. Mean discount rates (k) per year for small and large gains and losses, in Study 2. Error bars show ±one standard error

more frequently mentioned with larger magnitude outcomes. There was, however, a main effect of sign predicting the proportion of thoughts about earning interest on investment, $F(1,195) = 7.5$, $p = .007$, $\eta^2 = .04$, such that participants mentioned earning interest more often when considering gains (mean proportion = .24) than when considering losses (mean proportion = .12). This strikes us as intuitively plausible: it is easier for people to imagine the possible interest gained on a \$10 000 windfall than to imagine the interest forgone after a \$10 000 loss.

The pattern of present-biased thoughts seen in Figure 3 and Table 3 suggested that this might explain the observed interaction of magnitude and sign for predicting discount rates. Therefore, through mediation models, we tested whether the proportion of present-biased thoughts predict discount rates for gains and losses while controlling for magnitude, as summarized in Figure 4. We ran two separate mediation models, one for gains and one for losses (this was necessary because present bias has opposite effects on discount rates for gains and losses). For both gain and loss choices, larger magnitude outcomes led to a lower proportion of present-biased thoughts, and in both cases, the proportion of present-biased thoughts predicted discounting while controlling for magnitude (thus following the standard mediation model). However, as predicted and described in Table 1, the direction of the relationship between present-biased thoughts and discounting is opposite for gains and losses: a greater proportion of present-biased thoughts is associated with greater discounting of gains but lower discounting of losses. Both mediation models were significant ($p = .02$ for gains and $p = .03$ for losses), using a bootstrapping test with 10 000 replications, following the guidelines of Shrout and Bolger (2002). However, effect sizes were generally small (standardized betas in the range of .2 to .25), and the mediation was clearly only partial in both cases. Although we had no reason to expect that other thought categories would mediate the observed pattern of results, we also tested them, and indeed, none were significant mediators.

Discussion

As predicted, participants discounted large gains more than small gains, replicating the classic magnitude effect, but discounted small gains *less* than large gains, demonstrating a reverse magnitude effect. For both gains and losses, the effect of magnitude on discount rates was mediated by the prevalence of present-biased thoughts (wanting to have the gain now or get the loss over with now) relative to thoughts about other factors. In the case of gains, present bias leads to higher discount rates, whereas in the case of losses, it leads to lower discount rates. Consistent with previous research (Benhabib *et al.*, 2010), we found that present bias is relatively less influential when large outcomes are at stake: rather, preferences for large outcomes are dominated by concerns about uncertainty, earning interest on investments, and resource slack.

One question about our design and results is the extent to which financial constraints may have driven participants' choices, particularly in the \$10 000 loss condition. It is possible that some participants, with few resources immediately available, may have chosen to delay the \$10 000 loss because they had no way of paying immediately. Although this is consistent with our theory that present bias is relatively unimportant in the face of large magnitude outcomes, it suggests that the observed sign by magnitude interaction might disappear among wealthy

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participants. Therefore, in Study 2, we measured participants' available financial resources. Furthermore, we reduced the large magnitude outcome to \$1000, rather than \$10 000, to ensure that more participants could afford it. We predicted that the sign by magnitude interaction would persist in relatively wealthier individuals based on the fact that the majority of factors in Table 1 apply regardless of current wealth level.

A second concern about our design is that the process of listing thoughts about the decision process may have affected participants' preferences and choices. Therefore, in Study 2 we manipulated the order of thought listings to be either before or after participants made choices. Based on previous research (Weber *et al*., 2007), predicted that discount rates would not be affected by whether participants listed choices first or not.

A third concern about our design is that approximately 20% of thoughts were classified by participants as "other." Reviewing these thoughts, many were about simply wanting whichever was the larger gain or the smaller loss, so we added a new category in Study 2 to capture these responses. We also added examples to all thought categories to put them on even footing (previously, only two categories had examples).

STUDY 2

As in Study 1, sign and magnitude were manipulated between subjects. In addition, the order of thought listings was varied, such that half the participants listed their thoughts before making choices and half after.

Method

A sample of 305 US residents was recruited online via Amazon Mechanical Turk for a study on decision making. Participants were only eligible to participate if they had a prior approval rate above 98% and passed an attention check (Oppenheimer, Meyvis, & Davidenko, 2009) given on the first page (the pass rate was 80%). Median completion time was 13 minutes, compensation for which was \$1.36. Using the same criteria as Study 1, two participants were excluded for careless responding, leaving a total of 303 participants (56% female; mean age = 34, *SD* = 12) for further analysis.

For the complete materials, see Supporting Information B. The intertemporal choice task was the same as Study 1, with the following exceptions: (1) half the participants listed their thoughts before making their choices and half after making their choices, (2) both the gain and loss scenarios specified that "If you choose the future payment, the government will remind you to file the appropriate form 1 year from now.", and (3) the choice set ranged from \$6 to \$22 [\$600 to \$2200] (therefore, more strongly negative discount rates were possible than in Study 1).

The thought coding categories were similar to Study 1, with the addition of a new category, "The amount of money is the most important thing (for example, 'I will choose whichever amount is larger [smaller]')". We created this category on the basis of the content of numerous Study 1 thoughts classified as 'None of the above.'

After the thought listing, intertemporal choice task, and thought coding, participants answered the question, "Imagine that you had to pay an unexpected bill immediately. For example, suppose that you needed an expensive medical treatment that was not covered by insurance. Considering all possible resources available to you (including savings, borrowing, etc.), what is the maximum amount that you could come up with on short notice?," with a fill-in-the-blank response.

Results

Discount rates were inferred from participants' choices using the same procedure as in Study 1. Discount rates were unaffected by whether participants listed their thoughts before or after their choices; a general linear model (GLM) with thought order, sign, and magnitude predicting discount rates found no main effect of thought order, $F(1,295) = .1$, $p = .70$, $\eta^2 = .00$, no interaction of thought order and sign, $F(1,295) = .9$, $p = .34$, $\eta^2 = .00$, no interaction of thought order and magnitude, $F(1,295) = .9$, $p = .34$, $\eta^2 = .00$, and no three-way interaction, $F(1,295) = .0$, $p = .84$, $\eta^2 = .00$. Therefore, the following analyses collapse across order.

Replicating the results of Study 1, magnitude had opposite effects on discount rates for gains and losses, as seen in Figure 5. A 2×2 ANOVA revealed a main effect of sign, $F(1,299) = 165.5$, $p < .001$, $\eta^2 = .36$, a main effect of magnitude, $F(1,299) = 8.8$, $p = .003$, $\eta^2 = .03$, and a sign by magnitude interaction, $F(1,299) = 44.8$, $p < .001$, $\eta^2 = .13$. In dollar terms, participants considering gains were indifferent between receiving \$10 today or \$16 next year and between \$1000 today and \$1421 next year, whereas participants considering losses were indifferent between paying \$10 today or \$9 next year and between \$1000 today or \$1149 next year.

An interesting distributional difference was seen when comparing the discount rates for small and large losses. The distribution for large losses was more or less normal, centered around the mean. In contrast, the distribution for small losses was bimodal, with one group of responses clustered around a discount rate of −.70 per year (preferring to pay as soon as possible) and another other clustered around zero (preferring to minimize the amount paid, regardless of timing).

Participants listed 3.4 thoughts on average (*SD* = 1.8). As in Study 1, the proportion of present-biased thoughts was calculated by summing the number of thoughts coded as both "It's just what I want to do" *and* "favors receiving [paying] the money now" and dividing by the total number of thoughts listed by each individual. Table 4 summarizes the proportion of thoughts listed in each category. The new category, about whether the larger (or smaller) amount was chosen, was used quite commonly by participants, constituting about a quarter of their responses. Perhaps for this reason, the proportion of "other" thoughts was lower than in Study 1, as hoped. As seen in Figure 6, present-biased thoughts were relatively more common when participants considered small magnitude outcomes then when they considered large magnitude outcomes, $t(301) = 3.3$, $p = .001$, $d = .39$, consistent with our predictions. Bootstrapping tests showed that present-biased thoughts mediated the effect of magnitude on discount rates, in opposite directions for gains and losses, as summarized in

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Table 4. Summary of proportion of thoughts listed by participants for intertemporal choice involving gains and losses of different sizes, in Study 2

Motivational factor	\$10 gain	\$1000 gain	\$10 loss	\$1000 loss
Investment interest	.14	.08	.05	.10
Uncertainty	.12	.17	.21	.14
Resource slack	.18	.23	.09	.20
Present bias	.06	.03	.18	.07
Oughts	.09	.07	.14	.03
Amount	.26	.27	.22	.30
Other	.15	.16	.11	.16

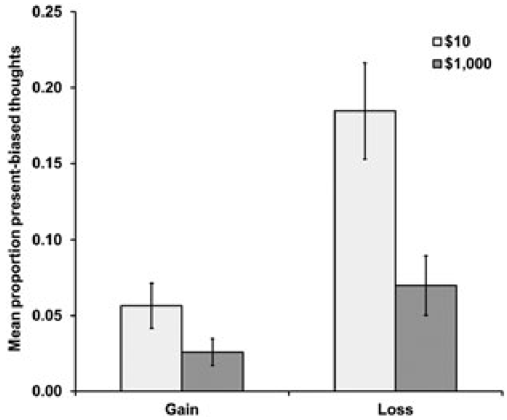

Figure 6. Mean proportion of present-biased thoughts, depending on the sign and magnitude of the outcomes, in Study 2. Error bars show ±one standard error

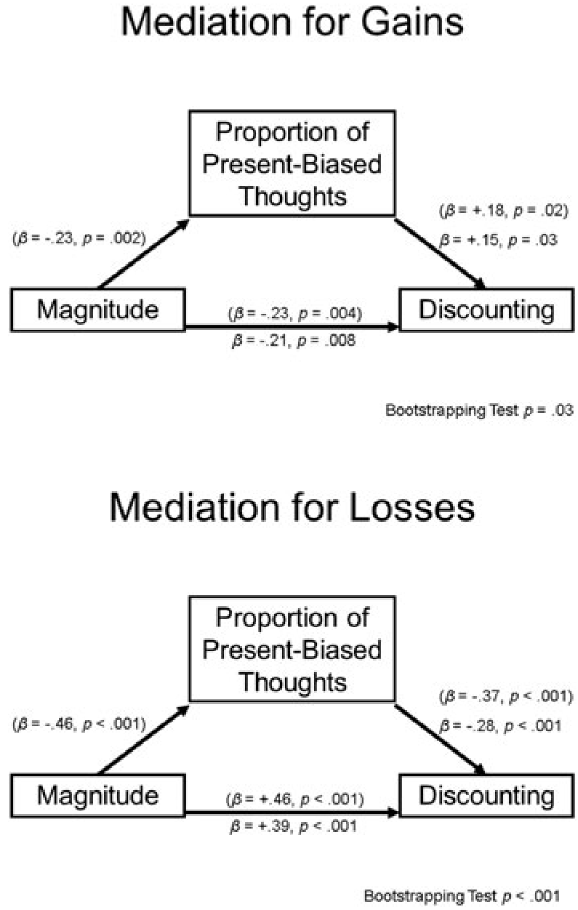

Figure 7. Mediation diagrams showing magnitude having an effect on discount rates through present-biased thoughts, separately for gains and losses, in Study 2. βs show standardized betas. Direct relationships are in parentheses. Note that the relationship between present-biased thoughts and discounting is positive for gains but negative for losses. The $p < .05$ statistic for the overall test of mediation for gains is a one-tailed test

Figure 7. The bootstrapping mediation test for gains was significant at $p = .03$ one-tailed (or $p = .06$ with a two-tailed test; we feel that the one-tailed test is appropriate given that we had specific hypotheses identical to those in Study 1), while the mediation test for losses was significant at $p < .001$.

The median participant reported having \$2000 immediately available for unexpected expenses (M = \$12 694, SD = \$30 210). We non-parametrically correlated available resources with discount rates. As seen in Table 5, participants with more resources available tended to show lower discount rates for gains and losses (although this relationship was non-significant for \$10 losses, it was in the same direction). In other words, participants with more financial resources were more likely to prefer waiting for future gains, and more likely to prefer paying losses immediately. Interestingly, although available resources was correlated with income, $\rho = .27$, $p < .001$, income was *not* a significant predictor of discount rates (although it showed trends in the same directions as available resources). To examine the relationship between available resources and the sign by magnitude interaction in more detail, we split the data according to whether participants reported having less than \$1000 immediately available or not and ran separate ANOVAs on each group. In both the insufficient resources group, $F(1,99) = 17.1$, $p < .001$, $\eta^2 = .15$, and the sufficient resources group, $F(1,196) = 32.9$, $p < .001$, $\eta^2 = .14$, the sign by magnitude interaction was significant, and the effect sizes were very similar. Taken together, these results indicate that although greater amounts of available resources are indeed associated with lower discount rates, the sign by magnitude interaction is equally as prevalent in richer participants as in poorer participants.

Table 5. Non parametric correlations (Spearman's rho) between available resources and discount rates for gains and losses of different sizes in Study 2 and Study 3

		Gain	Loss
Study 2	\$10	−.29**	−.16
	\$1000	−.43**	−.33**
Study 3	\$10	.12	−.07
	\$100	.11	.15
	\$1000	−.01	−.28*
	\$10 000	−.19	.00

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

Discussion

The results of Study 2 replicated the findings from Study 1. Sign and magnitude interacted to determine discount rates,

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and this effect was mediated by the prevalence of present-biased thoughts. Furthermore, the sign by magnitude interaction was equally robust whether participants were relatively more or less wealthy, and whether participants made their choices before or after listing their thoughts.

Studies 1 and 2 relied on extreme differences in magnitude between conditions to be sure we would observe the magnitude and reverse magnitude effects. In Study 3, we explored a number of different magnitudes ($10, $100, $1000, and $10 000) to determine how strong the effect is at various magnitudes. The theory of fixed-cost present bias predicts larger magnitude effects between lower magnitudes than between higher magnitudes (in other words, $4 worth of present bias means more when comparing $10 and $100 outcomes than when comparing $1000 and $10 000 outcomes). This prediction is supported by the similarity of the results of Study 1 (which used $10 000 outcomes for the large magnitude condition) and Study 2 (which used $1000 outcomes). Therefore, we predicted that discount rates in the $1000 and $10 000 conditions would not be significantly different from one another.

Another question concerns the sensitivity of the results to the range of options presented to participants. The scales we used in Study 1 and Study 2 allowed for large discount rates on the positive end but only for slightly negative discount rates on the lower end. This may affect participants' answers by restricting the range of response options and also by implicitly suggesting that high discount rates are normal and negative discount rates are extreme. Recent research comparing measurement methods has documented that scale choice systematically affects discount rates (Hardisty, Thompson, *et al.*, 2012). Therefore, in Study 3, we tested a scale of response options that was symmetric around the default amount, with equal numbers of options implying negative discount rates and positive discount rates. We predicted that this would lead to lower discount rates overall, compared with the results of Study 1 and Study 2.

STUDY 3

Methods

A sample of 322 US residents was recruited online via Survey Sampling International (SSI) for a study on decision making. As in Study 2, participants were only eligible to participate if they passed the attention check given on the first page (the pass rate was 20%[5]). Median completion time was 13 minutes, compensation was determined by SSI, and may have been a sweepstakes entry, direct pay, points, or other form. By using the same criteria as Studies 1 and 2, 22 participants were excluded for careless responding, leaving a total of 300 participants (57% female; mean age = 50, SD = 16) for further analysis.

Participants were randomly assigned to one of four magnitude conditions: $10, $100, $1000, and $10 000. All participants responded to one gain scenario and one loss scenario, in counterbalanced order. The scenarios were very similar to those used in Study 2 (for the exact text of the scenarios, see Supporting Information C), except that participants did not complete thought listings.[6] The titration scales were symmetric, ranging from 80% less than the immediate amount to 80% more than the immediate amount. For example, if the immediate amount was $10, the future amounts ranged from $2 to $18 (for the complete list of options, see Supporting Information C). After reporting their choices, participants indicated their available financial resources (in the same manner as Study 2) and answered demographic questions.

Results

One of the primary goals of the study was to examine discount rates when the options presented to participants were symmetric around a discount rate of zero. Although the choice options used in this study appear symmetric (ranging from 20% to 180% of the original amount), the resulting inferred discount rates are imbalanced. For example, a participant who is indifferent between paying $10 today and $18 in 1 year would have an exponential discount rate of .59, whereas a participant that is indifferent between paying $10 or $2 in 1 year would have an exponential discount rate of −1.61. Therefore, we elected to use the hyperbolic formula for this study, $V = A/(1 + kD)$ (Mazur, 1987), where V is the present value, A is the future amount, D is the delay,[7] and k is the discount rate. With this model, a participant who is indifferent between paying $10 today and $18 in 1 year would have a discount rate of .8 per year, whereas a participant that is indifferent between paying $10 or $2 in 1 year would have a discount rate of −.8 per year. Note that with our experimental design, the hyperbolic discount rate is identical to the ratio of the change in value to the immediate value (i.e., a hyperbolic discount rate of .8 indicates an 80% change in value).

Discount rates for losses were lower when losses were presented first ($M = -.22$, $SD = .45$) than when losses were presented second ($M = -.09$, $SD = .44$), $t(298) = 2.6$, $p = .009$, $d = .30$. However, order had no effect on discount rates for gains nor did it interact with magnitude. The remainder of the analyses collapse across order.

Replicating the results of Studies 1 and 2, discount rates varied as a function of outcome sign and magnitude, as seen in Figure 8. A 2 × 4 ANOVA revealed a main effect of sign, $F(1,296) = 39.1$, $p < .001$, $\eta^2 = .43$, a main effect of magnitude, $F(3,296) = 4.8$, $p = .003$, $\eta^2 = .05$, and a sign by magnitude interaction, $F(3,296) = 27.5$, $p < .001$, $\eta^2 = .22$. In dollar terms,

[5]Note that the pass rate for the attention check was much lower for the SSI sample (Study 3) than the Mechanical Turk sample (Study 2), even though the attention test was identical in each case and was given at the very beginning of the study in each case. This extremely low pass rate highlights the need for such checks, and the variability in quality between various online samples. Unfortunately, we cannot compare the data for participants who failed the checks with those who passed it, because those participants who failed the check were excluded from the rest of the study and we have no further data on them.

[6]We decided against collecting thought listings in this study because thought listings often do not work well in within-subjects designs (based on previous experience in our lab). Additionally, with eight conditions, a very large sample would have been needed to have adequate power for the mediation analyses.

[7]Note that the units of delay can potentially be anything. In our study, we are using the delay in years.

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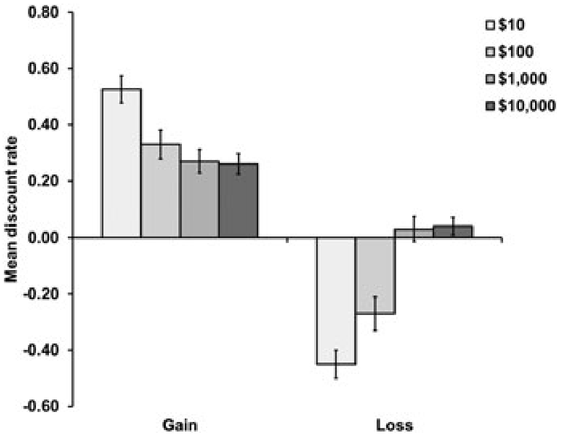

Figure 8. Mean discount rates (k) per year for gains and losses of different sizes, in Study 3. Error bars show ±one standard error

participants were on average indifferent between *receiving* \$10 immediately or \$15.30 in 1 year, \$100 or \$133 in 1 year, \$1000 or \$1270 in 1 year, and \$10 000 today or \$12 600 in 1 year. Concerning losses, participants were indifferent between *paying* \$10 today or \$5.50 in 1 year, \$100 today or \$73 in 1 year, \$1000 today or \$1030 in 1 year, and \$10 000 today or \$10 400 in 1 year. As seen in Figure 8 and confirmed with paired t-tests, discount rates for \$10-magnitude gains and losses were significantly different from all other magnitudes, all $p < .05$, $d = .4$ or better. Looking at the difference between the \$100 and \$1000 conditions, gains showed a non-significant trend in the expected direction, $t(146) = .8$, $p > .45$, $d = .13$, whereas losses showed a significant reverse magnitude effect, $t(146) = 4.4$, $p < .001$, $d = .73$. Discount rates for \$1000 outcomes were not significantly different from discount rates for \$10 000 outcomes, ps $> .5$ for gains and losses.

Zero and negative discount rates were extremely common, especially for smaller losses: 83% of participants in the \$10 loss condition expressed this preference, compared with 64% in the \$100 loss, 32% in the \$1000 loss condition, and 25% in the \$10 000 loss condition. For gains, 6% showed zero or negative discounting in the \$10 condition, 7% in the \$100 condition, 7% in the \$1000 condition, and 4% in the \$10 000 condition.

Similar to Study 2, the median participant reported having \$1350 immediately available for unexpected expenses ($M = \$13\,070$, $SD = \$63\,256$). We non-parametrically correlated available resources with discount rates. As seen in Table 5, the relationship between available resources and discount rates was weak, with only one significant result: participants with more resources available showed lower discount rates for \$1000 losses, as in Study 2. Available resources were correlated with income, $\rho = .35$, $p < .001$, but income was not a significant predictor of discount rates, again following the pattern of Study 2.

To examine the relationship between available resources and discount rates in more detail, we split the data according to whether participants reported having more resources than the base amount used in their condition. The sign by magnitude interaction was strong in both the richer group, $F(3,196) = 16.4$, $p < .001$, $\eta^2 = .20$, and the poorer group, $F(3,96) = 7.2$, $p < .001$, $\eta^2 = .19$, with very similar effect sizes.

Discussion

Replicating the results of Studies 1 and 2, larger magnitudes led to lower discounting of gains but greater discounting of losses. The sign by magnitude was equally strong in richer and poorer participants. However, the relationship between available resources and discount rates was weaker than in Study 2. Zero and negative discount rates were more common than in previous studies, probably because of the symmetric range of response options that participants considered. This range of options both allowed participants to show extremely negative discount rates and suggested to participants that negative discount rates were reasonable.

The range of outcomes tested in Study 3 showed that the magnitude and reverse magnitude effects were strongest when comparing \$10 outcomes to larger outcomes and tailed off to the point where \$1000 and \$10 000 outcomes were discounted at virtually identical rates. This is consistent with the fixed-cost present bias explanation of the magnitude effect.

GENERAL DISCUSSION

As observed in all three studies, losses can show a reverse magnitude effect in intertemporal choice. In other words, whereas people are more patient for large financial gains than small financial gains, they have a greater tendency to postpone large losses than small losses. Our studies are the first to demonstrate this reversal, which may be due to the fact that most studies of intertemporal choice do not allow participants to express zero or negative discount rates, because they take the rational-economic model of discounting as their point of departure.

We explain this reversal with a reconceptualization and generalization of present bias. We contend that in addition to people's desire to resolve intertemporal gains immediately, they also often have a psychological desire to resolve losses immediately. Such a present bias translates into higher discount rates for gains and lower discount rates for losses. Furthermore, we agree with Benhabib and colleagues (2010) that this present bias does not scale with magnitude, representing a sort of "fixed cost", which becomes relatively unimportant with large magnitude outcomes. As a result, people are impatient to have gains immediately, and people want to get losses over with as soon as possible, but this psychological concern is relatively unimportant in the face of large magnitude outcomes. For example, someone may prefer to deal with a small problem right away but put off large problems until later. Our process data support this theory, showing that present-biased thoughts mediate the effect of magnitude on discounting for both gains and losses.

It is important to note that although our research demonstrates that present bias remains relatively constant as a function of outcome magnitude, we do believe that present bias can be influenced by other factors, such as physical proximity (Hoch & Loewenstein, 1991) or appetitive stimuli (Li, 2008; Van den Bergh, Dewitte, & Warlop, 2008). For example, a consumer who smells warm chocolate chip cookies will likely be more impatient to eat them right away,

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and someone who visits the doctor for a vaccine may be anxious to get the shot over with as quickly as possible.

A shortcoming of these studies is that the effect sizes in the mediation models are somewhat small. This could be due to noise in our process measure: people rarely spontaneously mentioned impatience in their thought listings (particularly for gains). Another measure, such as directly asking participants how important impatience is for their decision, might yield stronger predictive power (although it is also likely that people do not want to admit to impatience and would find other reasons to justify their decisions). It is also possible that other factors contribute to the sign by magnitude interaction.

Alternative explanations of the magnitude effect

To the best of our knowledge, other than the theory of fixed-cost present bias, only three psychological explanations (i.e., process explanations) have been offered for the magnitude effect: *mental accounting*, *construal level*, and the *DRIFT model*. As described in the following paragraphs, however, none of these can be easily applied to people's time preferences for small and large losses.

According to the mental accounting theory (Loewenstein & Thaler, 1989), people discount small gains more steeply because small and large gains activate different mental accounts for which different discount rates may exist. When considering a small gain, people think of it as spending money, whereas when they consider a large gain, they think of it as a potential investment. Thus, small amounts are associated with immediate consumption accounts and their typically high discount rates, whereas large amounts are associated with long-term savings accounts and their typically lower discount rates. The mental accounting theory has not been explored with regards to losses, but presumably losses of different sizes might go into different accounts with different discount rates as well. This makes no specific predictions, however, about whether small or large losses would be discounted more.

Construal level theory (Trope & Liberman, 2003, p. 414) offers a complement to the mental accounting theory. It suggests that large magnitude outcomes trigger high-level construals, which lead to lower discount rates. While this is plausible, there is no data on whether larger magnitude outcomes do indeed activate high-level construals. More importantly, construal level theory does not predict the reverse magnitude effect with losses: there is no reason to expect high-level construals of losses to produce larger discount rates.

According to the DRIFT model (Read, Frederick, & Scholten, in press), intertemporal preferences are driven by the relative prominence of four outcome features: the absolute Difference between the two outcomes, the Ratio of the outcome difference to the sooner amount, the experimental Interest rate, and the degree to which the experimenter's offer is viewed as a consumption or Financial investment opportunity. When making intertemporal decisions, people balance these four DRIF factors against the importance of Time. The DRIFT model posits that the magnitude effect is a function of the degree of attention focused on feature *D*. "The magnitude effect occurs because multiplying two amounts by a common constant (>1) increases *D*, which shifts preference toward *LL* [the larger later amount]. For example, if \$100 and \$110 are doubled to \$200 and \$220, the difference between them will double from \$10 to \$20" (p. 7). The DRIFT model predicts that the size of the magnitude effect should depend on how big *D* is, as well as how much attention is paid to *D*. Consistent with the DRIFT model, Read and colleagues found that when outcomes were framed as total interest earned or rate of interest (thus drawing attention toward *R* or *I* and away from *D*) the magnitude effect was attenuated or eliminated. The predictions of the DRIFT model for losses of different magnitudes are unclear, but presumably the large absolute differences between immediate and future large magnitude losses would be expected to push participants away from the larger, later loss (and towards the smaller, sooner loss), thus predicting lower discount rates for larger magnitude. Therefore, it does not appear that the DRIFT model would predict the observed sign by magnitude interaction. In addition, the DRIFT model would predict that any magnitude effect for losses should be reduced or eliminated if outcomes are framed in terms of interest earned or rate of interest (rather than amounts, as studied in this paper). While we agree with this prediction, it should be tested empirically.

Future directions and implications

Throughout the paper, we have considered present bias as a descriptive label of an empirical fact, namely that on average people have a psychological desire to resolve gains and losses immediately.[8] However, questions remain about exactly how, when, and why people have this desire: although extensive literatures document present bias for gains (under the heading of impatience), and present bias for losses (under the heading of dread), the exact mechanisms have not been specified or tested. One possible mechanism, common to both gains and losses, is cognitive load: people want to resolve the situation immediately so they do not have to remember and monitor it in the future. Another possible common mechanism is a need for closure and certainty. The emotional underpinnings of present bias—such as feelings of deprivation (from expected gains) or anxiety (about looming losses)—reflect qualitatively different mechanisms of present bias for gains and losses. Future research should unpack exactly what present bias is, for both gains and losses, and the extent to which there is a common mechanism.

In addition to predicting the sign by magnitude interaction, our reconceptualization of fixed-cost present bias also predicts a preference reversal when a constant delay is added to both the immediate and future loss. For example, many people might prefer the sooner option when considering losing \$10 today

[8]There are certain cases where people experience pleasurable anticipation of future gains, rather than impatience, and so will be happy to postpone positive events (Loewenstein, 1987). For example, when thinking about a future vacation, most people find the waiting period enjoyable, rather than aversive. This is the exception, rather than the rule, however, as evidenced by the high discount rates typically observed for gains (Frederick *et al*., 2002). Furthermore, pleasurable anticipation of losses is extremely rare (Hardisty, Frederick, *et al*., 2012). Therefore, we posit that a psychological desire for the immediate resolution of both gains and losses is the most typical case.

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versus $9 in 1 year yet prefer the later option when considering losing $10 in 1 year versus $9 in 2 years. This type of preference reversal was recently documented with electric shocks (Harris, 2010), and we predict it should be observed with small financial losses as well. It would also be interesting to run a study and analysis identical to Benhabib and colleagues (2010), but with losses instead of gains, to determine whether the size of the present bias for losses (the desire to get them over with immediately) is also $4, or if it is a different amount. Finally, it is critical to examine mixed gain–loss intertemporal tradeoffs in more detail (Jones & Oaksford, 2011; Ostaszewski, 2007); many real life intertemporal choices require weighing an immediate gain (such as a dessert) against a future cost (such as health problems), or an immediate difficulty (such as a strenuous workout) against a future benefit (such as improved physical fitness).

Our findings may offer some guidance to policy makers hoping to encourage future-oriented decision making (i.e., low discount rates). As suggested by both previous research and the present findings, patience for gains may be encouraged by focusing on large magnitude outcomes. For example, an individual may be encouraged to save for retirement if the benefits of saving are aggregated over 10 years of savings, rather than only 1 year or 1 month. As the present research shows, however, the same strategy should *not* be applied to losses; people are motivated to take care of small losses immediately, but large losses are likely to be postponed until later. Therefore, a strategy of aggregating credit card debt or other debt into one large lump sum may be counterproductive and lead consumers to delay paying off the large debt. Rather, breaking the problem down into smaller pieces that can be taken care of immediately should be more effective. People will often choose to get losses over with immediately but only if they are small and manageable.

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