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Asymmetric Discounting of Gains *and* Losses: A Query Theory Account

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Abstract

People discount delayed gains (where the default is to receive a smaller gain sooner) more than accelerated gains (where the default is to receive a larger gain later). For losses, the pattern reverses—people discount delayed losses *less* than accelerated losses. In Study 1, confirming a Query Theory process account, this sign by direction interaction is mediated by the prominence of thoughts in favor of the default. Thoughts in favor of the smaller, sooner amount are more prominent in delay scenarios than acceleration scenarios, and this increases discounting for gains and decreases discounting for losses. Study 2 confirms the causal role of the order of option consideration. Participants considering thoughts in the natural order (pro–default thoughts first) replicate the sign by direction interaction, whereas participants considering thoughts in the opposite, unnatural order (pro-alternative thoughts first) do not. Reversing the order of option consideration eliminates the sign by direction interaction.

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Asymmetric Discounting of Gains *and* Losses: A Query Theory Account

Imagine expecting to receive $100 now, but being given the option to receive $110 in 3 months instead. Now imagine expecting to receive $110 in three months, but being given the option to receive $100 now. In both scenarios, several factors (e.g., uncertainty, Weber and Chapman 2005; Coble and Lusk 2010; resource slack, Zauberman and Lynch 2005; interest on investment, e.g., Franklin 1965; Samuelson 1937; and present bias, Benhabib et al. 2010; Laibson 1997) motivate us to prefer the sooner amount despite it being smaller. However, we tend to prefer the smaller, sooner amount more in the first scenario than in the second scenario. Our initial expectation of when we will receive the money influences our preferences such that we are more impatient when faced with a delay (when the default is to receive a smaller, sooner gain, but there is an option to receive a larger, later gain instead) than with an acceleration (when the default is to receive a larger, later gain, but there is an option to receive a smaller, sooner gain instead). This is the classic "direction effect": we discount delayed gains more than accelerated gains (Loewenstein 1988). For losses, however, this direction effect is reversed and we discount delayed losses *less* than accelerated losses (Benzion et al. 1989; Shelley 1993). For a summary table illustrating this interaction, see Table 1.

Why does the standard direction effect reverse for losses? Although these asymmetries in discounting are well established, to date no studies have collected process data and this interaction is largely unexplained. We use Query Theory as a process account to explain the effect of direction (delay vs. acceleration) on intertemporal choice. According to theories of preference construction, to arrive at a choice, people actively construct their preferences rather than merely recalling stored preferences (Frederick and Loewenstein 2008; Lichtenstein and Slovic 2006; Weber and Johnson 2009). Query Theory suggests that decision makers construct

their preferences by asking internal queries about the available choice options (e.g., $100 now or $110 later; Johnson et al. 2007; Weber et al. 2007; Weber and Johnson 2011). Specifically, Query Theory posits that queries are asked sequentially and that arguments for the default choice option are generated first. In other words, when presented with a delay scenario, people first query their episodic knowledge base for arguments in favor of the default (i.e., "What argues for choosing $100 now?"), before considering arguments in favor of the alternative (i.e., "What argues for choosing $110 later?"). Due to output interference, retrieval for later queries is less successful and, thus, the balance of support tends to favor the default option (Johnson et al. 2007).

Weber et al. (2007) used Query Theory to explain the direction effect within gains. For gains, the prominence of thoughts in favor of the default (thoughts in favor of the smaller, sooner gain for the delay scenario and thoughts in favor of the larger, later gain for the acceleration scenario) mediates the effect of direction on discounting (Weber et al. 2007). In other words, people have earlier and more impatient thoughts—and as a result they discount more—when the smaller, sooner gain is the default (delay) than when the larger, later gain is the default (acceleration). Query Theory has not yet been applied to discounting of losses[1].

Thus, Study 1 was designed to replicate the sign (gains vs. losses) by direction (delay vs. acceleration) interaction and to confirm and extend a Query Theory process account to the

[1] Indeed, very few studies of intertemporal choice have investigated discounting of losses. This is most likely due to the methodological difficulty of taking money away from participants at future dates (and the difficulty in getting human subjects boards to agree to this). However, studies comparing intertemporal choice for real and hypothetical gains found no differences in discount rates (Bickel et al. 2009, 2010; Johnson and Bickel 2002). Also, hypothetical discounting scenarios have been found to predict field behaviors of interest, such as smoking, obesity, and risky sexual behavior (Chabris et al. 2008; Chesson et al. 2006; Reimers et al. 2009). Further, a meta-analysis by Weber et al. (2004) on risky choice found that, although people were somewhat more risk averse for real than hypothetical outcomes, there was no interaction with sign. These results suggest that discounting of losses may be usefully studied using hypothetical scenarios.

discounting of losses. Building on these results, Study 2 was designed to confirm the causal role of thought order on discounting by manipulating the order in which options were considered.

1 Study 1

Study 1 investigated discounting using a between-subjects design (previous studies used within-subjects designs).[2] Specifically, Study 1 was designed to replicate and explain the sign by direction interaction (i.e., the direction effect for gains and the reverse direction effect for losses) using a Query Theory process account. Thus, we had several hypotheses:

H1: We will replicate standard discounting asymmetries.

> *H1a: Replicating the sign effect (Thaler 1981), gains will be discounted more than losses.*
>
> *H1b: Replicating the sign by direction interaction (Benzion et al. 1989; Shelley 1993), delayed gains will be discounted more than accelerated gains, whereas delayed losses will be discounted less than accelerated losses.*

H2: As predicted by Query Theory, across gains and losses, (a) thoughts in favor of the default option will cluster earlier than thoughts in favor of the alternative option; (b) there will be more thoughts in favor of the default option than in favor of the alternative option; and (c) the effect of the default on the relative number of thoughts in favor of the default option will be mediated by the clustering of thoughts.

H3: We will find support for a Query Theory process account of the sign by direction interaction for gains and for losses.

[2] Replicating the interaction using a different study design provides convergent validity for the finding. Additionally, data from a pilot study using a within-subjects design revealed order effects in respondents' answers. More generally, Birnbaum (1982) argues that we cannot and should not generalize results from within-subjects designs to between-subjects designs, and vice versa.

H3a: Thoughts in favor of the smaller, sooner option ("now" thoughts) will be more prominent in delay scenarios than acceleration scenarios for gains and *for losses*

H3b: The prominence of now thoughts will predict discounting, albeit in opposite directions for gains and losses.

Although this may seem like a counterintuitive prediction, it is a direct result of how discounting operates—wanting to realize a gain now is equivalent to a high discount rate and wanting to realize a loss now is equivalent to a low discount rate. Thus, if more prominent now thoughts lead to a desire to realize outcomes now, they will lead to *greater* discounting of gains and to *lower* discounting of losses.

H3c: The prominence of now thoughts will mediate the effect of direction on discounting for gains and *losses.*

1.1 Method

1.1.1 Participants

U.S. residents (N = 752) were recruited and run online through the Center for Decision Sciences' Virtual Lab.[3] Participants were compensated $4 for their time. Data from 145 (19%) participants were excluded for one of four reasons:[4] (1) 80 participants did not complete the study or had missing data due to a technical error, (2) 26 participants had nonmonotonic or perverse preferences in the choice titrator,[5] (3) 10 participants provided extreme and inconsistent

[3] Participants had to have a valid U.S. IP address to participate.
[4] Both the nature and magnitude of our exclusions are typical for online research, which trades off the advantages of a more representative sample of participants in terms of socioeconomic variables with the disadvantages of decreased survey supervision (e.g., Hardisty and Weber 2009). Excluding data from careless respondents makes the data less noisy without altering major trends or conclusions.
[5] Nonmonotonic responses switched back and forth between now and later amounts more than one time. Perverse responses switched from the varying amount to the fixed amount (e.g., indicated a preference for a smaller, later gain over a larger, sooner gain).

responses on the choice titrator and a follow-up matching question,[6] and (4) 29 participants had extreme survey completion times (i.e., outside two standard deviations of the mean of the natural logarithm of time; M_{time} = 16.08 minutes, $M_{ln\ time}$ = 2.63, S*D* = 0.52).

Analyses were based on the data from the remaining 607 participants (75% female, M_{age} = 37.51, *SD* = 11.95). Participants came from a range of socio-economic backgrounds: 80% had at least a two-year college degree, 59% were married, 64% had children, and the median household income was in the $50,000-$99,999 bracket.

1.1.2 Procedure

Study 1 used a 2 (sign: gain vs. loss) x 2 (direction: delay vs. acceleration) between-subjects design. First, participants completed a practice thought-listing task. Participants were then randomly assigned to read one of four hypothetical decision scenarios: delayed gain, accelerated gain, delayed loss, or accelerated loss. Before recording their decisions, participants used a type-aloud protocol to record their thoughts about the scenarios. Participants subsequently coded their own previously-recorded thoughts into categories. Lastly, participants reported demographic information.

1.1.3 Materials

Discounting scenarios Participants read a hypothetical scenario indicating that they had been selected to receive a gift certificate (gain) or that they had been fined for a parking violation

[6] After the choice titrator, a matching question asked participants to specify the amount of the alternative option that would make it as attractive as the default option. This question was used only as an exclusion criterion for participants who in the choice titrator always preferred the fixed amount or always preferred the varying amount (i.e., did not switch). Participants were excluded if they did not switch on the choice titrator, but then indicated a contradictory amount on the matching question (e.g., a participant in the delayed gain condition who preferred $50 today over any amount $40-90 in 3 months, but indicated $10 as the amount in 3 months that would be equally attractive to $50 today).

(loss). Participants in the delayed gain [loss] condition chose between receiving [paying] $50 now and receiving [paying] a larger amount in three months instead. Participants in the accelerated gain [loss] condition chose between receiving [paying] $75 in three months and receiving [paying] a smaller amount now instead.[7]

Thought listing Participants completed a warm-up thought-listing task to learn how to use the thought-listing interface. Then, after reading the discounting scenarios, participants were prompted to report any thoughts that went through their minds as they contemplated the scenario. They listed these thoughts one by one using a type-aloud protocol (Johnson et al. 2007; Weber et al. 2007).

Choice titration Participants in the delayed gain [loss] condition were given a series of choices between the default of receiving [paying] $50 now and a different amount three months from now. The delayed (later) amount ranged from $40 to $90 in $5 increments. Participants in the accelerated gain [loss] condition were given a series of choices between the default of receiving [paying] $75 three months from now and a different amount now. The accelerated (now) amount ranged from $35 to $85 in $5 increments. The assumed indifference point was the value midway between the dollar amounts of the varying gift certificate [fine] at which participants switched from consistently preferring the fixed amount to consistently preferring the varying amount.[8]

Thought coding Participants coded each of their own previously-listed thoughts as favoring receiving [paying] now, favoring receiving [paying] later, or favoring neither.

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[7] In order to replicate and extend Weber et al.'s (2007) findings, we used their scenarios for the gain conditions and created modified scenarios for the loss conditions.

[8] If participants did not switch (i.e., always preferred the fixed amount or always preferred the varying amount), we assumed that their indifference point was just outside the range of the titrator (i.e., in the delayed gain condition, a participant always preferring the fixed amount would be assumed to have an indifference point of $92.50 whereas a participant always preferring the varying amount would be assumed to have an indifference point of $37.50). We find the same pattern of results when we assume more extreme indifference points.

1.2 Results

1.2.1 Asymmetric Discounting

To test for replications of the sign effect (H1a: gains are discounted more than losses) and the sign by direction interaction (H1b: the direction effect for gains and the reverse direction effect for losses), we investigated participants' intertemporal choices. Discount rates were quantified using the hyperbolic equation, $k = (A - V) / (V * D)$, where A is the delayed amount, V is the immediate amount, and D is the delay in years (Mazur 1987). Increasing values of k indicate greater discounting (i.e., k functions like a discount rate). In other words, people who report a positive value of k value the present more than the future (i.e., they prefer to receive gains now and pay losses later), whereas people who report a negative value of k value the future more than the present (i.e., they prefer to receive gains later and pay losses now).

We conducted a 2 (sign: gain vs. loss) x 2 (direction: delay vs. acceleration) univariate analysis of variance. As predicted by hypothesis 1a and replicating the sign effect, participants discounted gains (k = 1.14, SD = 1.21) significantly more than losses (k = 0.28, SD = 0.97), $F(1, 603) = 94.23$, $p < .001$, *partial* $\eta^2 = 0.14$. As predicted by hypothesis 1b, the main effect of direction was *not* significant (across sign), $F(1, 603) = 2.61$, $p = .11$, *partial* $\eta^2 = .004$, but the interaction of sign and direction *was* significant, $F(1, 603) = 25.71$, $p < .001$, *partial* $\eta^2 = .04$. As shown in Figure 1 and replicating the sign by direction interaction, participants discounted delayed gains *more* than accelerated gains, but delayed losses *less* than accelerated losses (see Table 2 for descriptive statistics). Planned contrast tests showed that the direction effect was significant for gains, $t(603) = 2.18$, $p = .03$, *Cohen's d* = .25, and the reversed direction effect was highly significant for losses, $t(603) = -5.46$, $p < .001$, *Cohen's d* = .63. Supporting hypothesis 1a, participants discounted gains more than losses (replicating the sign effect).

Supporting hypothesis 1b, participants discounted delayed gains more than accelerated gains, and delayed losses less than accelerated losses (replicating the sign by direction interaction).

1.2.2 Clustering and Balance of Thoughts

We examined the clustering and ordering of thoughts as well as the relative number of thoughts to test three tenets of Query Theory: (H2a) thoughts in favor of the default option cluster earlier than thoughts in favor of the alternative option; (H2b) there are more thoughts in favor of the default option than in favor of the alternative option; and (H2c) the effect of the default on the relative number of thoughts in favor of the default option is mediated by the clustering of thoughts.

Participants listed between 1 and 12 thoughts ($M = 2.91$, $SD = 1.60$). Number of thoughts did not differ by condition, ps > .1. We measured thought clustering and order using the standardized median rank difference metric: $SMRD = 2(MR_L - MR_N)/n$, where MR_L is the median rank of thoughts favoring receiving/paying later ("later thoughts"), MR_N is the median rank of thoughts favoring receiving/paying now ("now thoughts"), and n is the total number of relevant thoughts (Johnson et al. 2007; Weber et al. 2007).[9] Positive [negative] numbers indicate that now thoughts clustered earlier [later] than later thoughts, and randomly interspersed now and later thoughts produce a SMRD of zero.

As predicted by Query Theory and hypothesis 2(a, b, and c), across sign, now thoughts occurred significantly earlier in the delay conditions (when now was the default; $M = 0.55$, $SD = 0.79$) than in the acceleration conditions (when later was the default; $M = 0.28$, $SD = 0.91$), $t(561) = 3.75$, $p < .001$, *Cohen's d* = .32; there were relatively more now thoughts (the number

[9] Data from 44 participants providing only irrelevant thoughts (thoughts coded as neither favoring now nor favoring later) were excluded from all analyses on participants' thoughts.

of now thoughts minus the number of later thoughts) in the delay conditions (M = 1.08, SD = 1.98) than in the acceleration conditions (M = 0.68, SD = 2.07), $t(561) = 2.33$, $p = .02$, *Cohen's d* = .20; and the effect of direction (delay vs. acceleration) on the relative number of now thoughts was fully mediated by thought order as measured by SMRD, $p < .001$ (see Appendix A for the full mediation analysis). When the default was to receive [pay] now, thoughts favoring receiving [paying] now were clustered earlier, which led to a greater relative number of these thoughts. This supports Query Theory's output interference account: early thoughts in favor of the default option inhibit later thoughts about the alternative option and, thus, the balance of support favors the default option.

1.2.3 Prominence of Now Thoughts

We next wanted to test hypothesis 3a: As predicted by Query Theory, now thoughts are more prominent for delayed outcomes than accelerated outcomes across sign (i.e., a main effect of direction, but no sign by direction interaction). Thus, we created a measure of the *prominence of now thoughts* for the thoughts that each participant generated about his/her decision by averaging the z-scores of SMRD and the relative number of now thoughts.[10] Higher numbers indicate a greater prominence of now thoughts (i.e., earlier and more numerous now thoughts).

We conducted a 2 (sign: gain vs. loss) x 2 (direction: delay vs. acceleration) univariate analysis of variance. As shown in Figure 2, now thoughts were significantly more prominent for loss decisions (M = 0.26, SD = 0.74) than gain decisions (M = -0.40, SD = 1.04), $F(1, 559) = 78.93$, $p < .001$, *partial* $\eta^2 = 0.12$. As predicted by Query Theory, now thoughts were significantly more prominent for delay decisions (M = 0.14, SD = 0.86) than acceleration

[10] SMRD and the relative number of now thoughts are highly correlated, $r(563) = .64$, $p < .001$, which provides justification for our creation of a summary index combining the two.

decisions (M = -0.12, SD = 0.97), $F(1, 559) = 15.12$, $p < .001$, *partial* $\eta^2 = .03$. The sign by direction interaction was marginally significant, $F(1, 559) = 2.94$, $p = .09$, *partial* $\eta^2 = .005$, reflecting the fact that the difference in means was larger within gains than within losses. Confirming hypothesis 3a and as predicted by Query Theory, participants thought about acting now earlier and more often when considering delaying (vs. accelerating) gains or losses. Unexpectedly, participants also thought about acting now earlier and more often when considering losses (vs. gains); we will return to this result in the Discussion (Section 1.3).

1.2.4 Prominence of Now Thoughts and Discounting

Next, we wanted to test hypothesis 3b that, as predicted by Query Theory, the prominence of now thoughts predicts discounting of both gains and losses, albeit in opposite directions.[11] We used linear regressions. As predicted, for gains, a greater prominence of now thoughts translated to *greater* discounting, $B = 0.60$, $SE = 0.07$, $t(206) = 8.67$, $p < .001$, *partial* $r^2 = .27$. Also as predicted, for losses, a greater prominence of now thoughts translated to *lower* discounting, $B = -0.60$, $SE = 0.06$, $t(353) = -9.69$, $p < .001$, *partial* $r^2 = .21$. In other words, confirming hypothesis 3b, earlier and more thoughts about *receiving* money now translated to greater discounting of gains, whereas earlier and more thoughts about *paying* money now translated to lower discounting of losses.

1.2.5 Mediation of Discounting by Prominence of Now Thoughts

Lastly, to test hypothesis 3c that the prominence of now thoughts mediates the relationship between direction and discounting for gains and for losses, we conducted two series of linear

[11] Again, although this may seem like a counterintuitive prediction, it is due to the fact that wanting to realize a gain now is equivalent to a high discount rate whereas wanting to realize a loss now is equivalent to a low discount rate. Thus, if more prominent now thoughts lead to a desire to realize outcomes now, they will lead to greater discounting of gains and to lower discounting of losses.

regressions (one for gains and one for losses), each following the steps outlined by Baron and Kenny (1986) and Shrout and Bolger (2002). Figure 3 summarizes the mediation analyses (see Appendix B for the full analyses). Bootstrapping tests (as recommended by Shrout and Bolger 2002) confirmed that the prominence of now thoughts significantly mediated the relationship between direction and discounting for gains (p = .004) and for losses (p = .03). Confirming hypothesis 3c and as predicted by Query Theory, for gains *and* for losses, direction influenced the prominence of now thoughts, which, in turn, influenced discounting. Specifically, now thoughts were more prominent for delayed outcomes than accelerated outcomes and this led to increased discounting of gains and reduced discounting of losses.

1.3 Discussion

Using a between-subjects design, in support of hypothesis 1, Study 1 replicated the sign effect and the sign by direction interaction effect (i.e., the direction effect for gains and the reverse direction effect for losses). Participants discounted gains more than losses. They also discounted delayed gains more than accelerated gains, but delayed losses *less* than accelerated losses. More importantly, our use of process data (i.e., thought listings) allowed us to provide, for the first time, a process-level account for the sign by direction interaction indicating that the prominence of now thoughts predicted discounting for gains *and* losses.

Confirming a Query Theory process account, not only did the order of now thoughts mediate the effect of direction on the relative number of now thoughts (hypothesis 2), but the overall prominence of now thoughts mediated the effect of direction on discounting (hypothesis 3). Across gains and losses, now thoughts were more prominent in delay scenarios (when the default option was to receive/pay now) than acceleration scenarios (when the default option was

to receive/pay later). For gains, greater prominence of now thoughts led to greater discounting whereas, for losses, it led to less discounting.

There was an unexpected effect of sign on the prominence of now thoughts—participants had more prominent now thoughts for losses than gains. Although Query Theory did not directly predict this finding, it may be a result of losses looming larger than equivalent gains (e.g., Kahneman et al. 1991; Novemsky and Kahneman 2005; Tversky and Kahneman 1991), which may cause the default in the loss scenarios to be experienced more strongly than the default in the gain scenarios. Stronger defaults would be expected to induce more prominent thoughts in favor of the default option.

Study 1 extended Query Theory to the discounting of losses. Participants considered the default option before the alternative option, which led to more thoughts in favor of the default option and also mediated the effect of direction on discounting of gains *and* losses. However, the evidence for Query Theory in Study 1 was correlational in nature. Thus, it is unclear whether differences in the order in which arguments supporting the two choice options were listed directly influenced participants' choices (as hypothesized), or whether participants' choices were determined by some other process (with differences in thought order merely representing a by-product rather than a cause of differences in choice). Study 2 therefore tested whether the order of option consideration plays a *causal* role in intertemporal choice by manipulating the order in which participants were asked to list their thoughts.

2 Study 2

Query Theory posits that different framings of the same choice suggest different natural defaults (Johnson et al. 2007; Weber et al. 2007). Namely, in delay-framed intertemporal choice scenarios, the natural default option is the smaller, sooner gain [loss] and the alternative option is

a larger, later gain [loss]. By contrast, in acceleration-framed intertemporal choice scenarios, the natural default option is the larger, later gain [loss] and the alternative option is a smaller, sooner gain [loss]. According to Query Theory, thoughts in favor of the default are considered before thoughts in favor of the alternative and this in turn determines discounting. Weber and colleagues (2007) manipulated thought order and found that it had a direct causal effect on the discounting of gains. Therefore, to test whether the order in which thoughts are considered affects discounting of both gains and losses, in Study 2, we manipulated thought order.

In the natural thought order conditions, participants were asked to consider thoughts in favor of the default (i.e., "now" thoughts in the delay scenarios and "later" thoughts in the acceleration scenarios) before thoughts in favor of the alternative (i.e., "later" thoughts in the delay scenarios and "now" thoughts in the acceleration scenarios). In the unnatural thought order conditions, this was reversed and participants were asked to consider thoughts in favor of the alternative (i.e., "later" thoughts in the delay scenarios and "now" thoughts in the acceleration scenarios) before thoughts in favor of the default (i.e., "now" thoughts in the delay scenarios and "later" thoughts in the acceleration scenarios). For example, in the delay conditions, the natural order was to consider thoughts in favor of the smaller, sooner option first, whereas the unnatural order was to consider thoughts in favor of the larger, later option first. Weber et al. (2007) found that reversing the natural thought order eliminated the direction effect for discounting of gains. Thus, we had two hypotheses:

H4: (a) The natural thought order conditions will replicate Study 1 and find a sign by direction interaction. (b) In the unnatural thought order conditions, the sign by direction interaction will be eliminated or even reversed.

H5: (a) The natural thought order conditions will replicate Study 1: thoughts in favor of the smaller, sooner option ("now" thoughts) will be more prominent in delay scenarios than acceleration scenarios for gains and for losses. (b) In the unnatural thought order conditions, this pattern will be reversed: thoughts in favor of the smaller, sooner option ("now" thoughts) will be more prominent in acceleration *scenarios than delay scenarios for gains and for losses.*

2.1 Method

2.1.1 Participants

U.S. residents (N = 617) were recruited and run online through the Center for Decision Sciences' Virtual Lab in the same manner as Study 1. Participants were compensated $4 for their time. Data from 338 (55%) participants were excluded for any of the following reasons: (1) 41 participants did not complete the study or had missing data due to a technical error, (2) 45 participants had nonmonotonic or perverse preferences in the choice titrator,[12] and (3) 252 participants did not complete the study in good faith:[13] (a) 10 participants had extreme survey completion times (i.e., outside two standard deviations of the mean of the natural logarithm of time; M_{time} = 15.34 minutes, $M_{ln\ time}$ = 2.50, S*D* = 0.66), (b) 182 participants failed an attention-screening task, (c) 20 participants listed nonsensical thoughts in the thought-listing task, and (d) 40 participants listed the wrong type of thoughts in the first thought-listing task (e.g., listed thoughts favoring receiving/paying now when asked for thoughts favoring receiving/paying later or vice versa).[14]

[12] As in Study 1, nonmonotonic responses switched back and forth between now and later amounts more than one time. Perverse responses switched from the varying amount to the fixed amount (e.g., indicated a preference for a smaller, later gain over a larger, sooner gain).

[13] Analyses including participants who did not complete the study in good faith show similar, albeit weaker, patterns of results.

[14] Although there were slightly more participants who disregarded instructions in the unnatural order than in the natural order, this difference was not significant, $p > .5$.

Analyses were based on the data from the remaining 279 participants (70% female, M_{age} = 39.82, *SD* = 12.69). Participants came from a range of socio-economic backgrounds: 74% had at least a two-year college degree, 53% were married, 59% had children, and the median household income was in the $50,000-$99,999 bracket.

2.1.2 Procedure

Study 2 used a 2 (thought order: natural vs. unnatural) x 2 (sign: gain vs. loss) x 2 (direction: delay vs. acceleration) between-subjects design. First, participants completed an attention-screening task and a practice thought-listing task. Participants were then randomly assigned to read one of four hypothetical decision scenarios: delayed gain, accelerated gain, delayed loss, or accelerated loss. Before recording their decisions, participants were prompted to list their thoughts, by random assignment, in the natural order or the unnatural order. After recording their decisions, participants coded their own previously-recorded thoughts into categories. Lastly, participants reported demographic information.

2.1.3 Materials

Attention screener Participants were presented with a short paragraph of text in the middle of which was an instruction to answer the subsequent three questions with the word "reader."

Discounting scenarios The discounting scenarios were the same as in Study 1.

Thought listing Participants completed a warm-up thought-listing task to learn how to use the thought-listing interface. Then, after reading the discounting scenarios, participants completed two separate thought-listing tasks.

In the natural thought order conditions, participants were first asked to list all of their thoughts in favor of the natural default: in the delay [acceleration] conditions, participants were asked to list their thoughts in favor of receiving/paying now [later], whether these thoughts were about why it would be good to receive/pay now [later] or about why it would be bad to receive/pay later [now]. They were then asked to list all of their thoughts in favor of the alternative: in the delay [acceleration] conditions, participants were asked to list their thoughts in favor of receiving/paying later [now], whether these thoughts were about why it would be good to receive/pay later [now] or about why it would be bad to receive/pay now [later].

In the unnatural thought order conditions, this order was reversed. Participants were first asked to list all of their thoughts in favor of the alternative (i.e., receiving/paying later in the delay conditions and receiving/paying now in the acceleration conditions) and then asked to list all of their thoughts in favor of the default (i.e., receiving/paying now in the delay conditions and receiving/paying later in the acceleration conditions).

Choice titration The discounting scenarios and methods of inferring indifference points were the same as in Study 1.

Thought coding As in Study 1, participants coded each of their own previously-listed thoughts as favoring receiving [paying] now, favoring receiving [paying] later, or favoring neither.

2.2 Results

2.2.1 Asymmetric Discounting

To test for a replication of the sign by direction interaction in the natural thought order (H4a) and an elimination or reversal of the sign by direction interaction in the unnatural thought order (H4b), we investigated participants' intertemporal choices. As in Study 1, we used the discount

parameter, *k*. We conducted separate 2 (sign: gain vs. loss) x 2 (direction: delay vs. acceleration) univariate analyses of variance for the natural and unnatural thought order conditions.

In the natural thought order, we replicated the sign effect: participants discounted gains ($k = 0.94$, $SD = 0.90$) significantly more than losses ($k = 0.18$, $SD = 0.82$), $F(1, 137) = 28.50$, $p < .001$, *partial* $\eta^2 = 0.17$. Also replicating Study 1, the main effect of direction was *not* significant (across sign), $F(1, 137) = 0.28$, $p > .5$, *partial* $\eta^2 = .002$, but the interaction of sign and direction *was* significant, $F(1, 137) = 16.43$, $p < .001$, *partial* $\eta^2 = .11$. As shown in Figure 4a, participants discounted delayed gains *more* than accelerated gains, but delayed losses *less* than accelerated losses (see Table 3 for descriptive statistics). Planned contrast tests showed that the direction effect was highly significant for gains, $t(137) = 3.15$, $p = .002$, *Cohen's d* = .76, and the reversed direction effect was significant for losses, $t(137) = -2.57$, $p = .01$, *Cohen's d* = .63. Supporting hypothesis 4a, in the natural thought order conditions, we replicated Study 1 by finding a significant sign effect as well as a significant sign x direction effect. When participants were asked to list their thoughts in the natural order, participants discounted delayed gains more than accelerated gains, but delayed losses less than accelerated losses.

In the unnatural thought order conditions, we once again replicated the sign effect: participants discounted gains ($k = 0.94$, $SD = 0.80$) significantly more than losses ($k = 0.42$, $SD = 1.03$), $F(1, 134) = 11.00$, $p = .001$, *partial* $\eta^2 = 0.08$. As expected, the main effect of direction was *not* significant (across sign), $F(1, 134) = 0.31$, $p > .5$, *partial* $\eta^2 = .002$. Most importantly, as shown in Figure 4b, the interaction of sign and direction was *not* significant, $F(1, 134) = 1.04$, $p > .2$, *partial* $\eta^2 = .008$ (see Table 3 for descriptive statistics). Supporting hypothesis 4b, in the unnatural thought order conditions the sign by direction effect was eliminated. When participants

were asked to list their thoughts in the unnatural order, there were no significant differences in discounting between the delay and acceleration conditions, for gains or for losses.

2.2.2 Prominence of Now Thoughts

We next wanted to test whether now thoughts are more prominent for delayed outcomes than accelerated outcomes in the natural thought order (H5a), and whether later thoughts are more prominent for accelerated outcomes than delayed outcomes in the unnatural thought order (H5b). We once again created a measure of the *prominence of now thoughts* by averaging the z-scores of SMRD and the relative number of now thoughts ($r(275) = .33$, $p < .001$).[15] Higher numbers indicate a greater prominence of now thoughts (i.e., earlier and more now thoughts). We conducted separate 2 (sign: gain vs. loss) x 2 (direction: delay vs. acceleration) univariate analyses of variance for the natural and unnatural thought order conditions.

In the natural thought order, replicating Study 1, now thoughts were significantly more prominent for loss decisions ($M = 0.20$, $SD = 0.99$) than gain decisions ($M = -0.18$, $SD = 0.73$), $F(1, 135) = 11.88$, $p = .001$, *partial* $\eta^2 = 0.08$. More importantly, as shown in Figure 5a, now thoughts were significantly more prominent for delay decisions ($M = 0.70$, $SD = 0.58$) than acceleration decisions ($M = -0.72$, $SD = 0.50$), $F(1, 135) = 244.90$, $p < .001$, *partial* $\eta^2 = .65$. The sign by direction interaction was not significant, $F(1, 135) = 2.38$, $p = .1$, *partial* $\eta^2 = .02$. Supporting hypothesis 5a, in the natural thought order conditions, participants thought about acting now earlier and more often when considering delaying (vs. accelerating) gains or losses. Replicating Study 1, participants also thought about acting now earlier and more often when considering losses (vs. gains).

[15] Data from 4 participants providing only irrelevant thoughts (thoughts coded as neither favoring now nor favoring later) were excluded from all analyses on participants' thoughts.

In the unnatural thought order, once again now thoughts were significantly more prominent for loss decisions (M = 0.07, SD = 0.68) than gain decisions (M = -0.12, SD = 0.77), $F(1, 132) = 8.88$, $p = .003$, *partial* $\eta^2 = 0.06$. More importantly, as shown in Figure 5b, now thoughts were significantly more prominent for *acceleration* decisions (M = 0.55, SD = 0.35) than delay decisions (M = -0.63, SD = 0.50), $F(1, 132) = 277.24$, $p < .001$, *partial* $\eta^2 = .68$. The sign by direction interaction was not significant, $F(1, 132) = 1.75$, $p > .15$, *partial* $\eta^2 = .01$. Supporting hypothesis 5b, in the unnatural thought order conditions, participants thought about acting now earlier and more often when considering *accelerating* (vs. delaying) gains or losses. Replicating Study 1, participants also thought about acting now earlier and more often when considering losses (vs. gains).

2.3 Discussion

Study 2 found evidence for a causal link between the order of option consideration and discounting. In support of hypothesis 4a, the natural thought order conditions replicated the sign by direction interaction from Study 1: when participants were asked to list thoughts in favor of the natural default first, participants discounted delayed gains more than accelerated gains, but delayed losses *less* than accelerated losses. In the unnatural thought order conditions, confirming hypothesis 4b, the sign by direction interaction was eliminated; when participants were asked to list thoughts in favor of the alternative first, there were no differences between delay and acceleration for gains or for losses.

Study 2 also further confirmed the Query Theory process account: In the natural thought order conditions, across gains and losses, now thoughts were more prominent in *delay* scenarios than acceleration scenarios. In the unnatural thought order conditions, across gains and losses, now thoughts were more prominent in *acceleration* scenarios than delay scenarios. When asked

to consider the default first, participants had more prominent thoughts in favor of the default, and discounted accordingly. When asked instead to consider the alternative first, participants had more prominent thoughts in favor of the alternative, and discounted accordingly.

The unnatural thought order conditions reversed the direction effect for the prominence of now thoughts and eliminated (but did not reverse) the sign by direction interaction for choices. As suggested by Weber et al. (2007), this may be due to the strength of the default option and the natural tendency to consider thoughts in favor of the default option first. Although participants in the unnatural thought order conditions followed instructions and *reported* thoughts in favor of the alternative first, they may still have, implicitly or explicitly, considered thoughts in favor of the default first. This suggests that stronger manipulations (e.g., requiring more thoughts in favor of the alternative option and fewer thoughts in favor of the default option, or giving participants more extensive training in the technique of considering the opposite first) may be able to fully reverse the effect of the default.

3 General Discussion

Because our studies are the first to investigate the processes underlying discounting of losses and to compare them to the processes underlying discounting of gains, our results can uniquely inform interventions to help decision makers make intertemporal choices they are less likely to subsequently regret. Indeed, all too frequently, people faced with intertemporal choices make decisions that they later regret—the dieter who succumbs to the dessert tray (e.g., Metcalfe and Mischel 1999), the worker who retires with insufficient savings (e.g., Thaler and Benartzi 2004), and the community that overfishes their lake (e.g., Hendrickx et al. 2001). Impatience in all of these domains represents a present bias where people want good things now, in part because the immediate option offers greater certainty. This is codified into popular culture in the form of

injunctive norms, found in proverbs like "A bird in hand is worth two in the bush," which can be found in most cultures (Weber et al. 1998).

Because the intertemporal choice literature has focused on gain decisions and because people discount gains less in acceleration than delay frames, a naïve policymaker might assume that acceleration frames are a general panacea to reduce discounting. Our studies show, however, that the story is more nuanced. They also underscore the need for a multidisciplinary analysis of reasons for discounting that includes psychological as well as economic motivators and their interactions (e.g., Hardisty et al. 2011). Gains and losses are discounted differently and for a somewhat different set of reasons, and these differences must be taken into account to craft successful public policies. For gains, impatience (i.e., the desire to have the gain now) increases discounting. To decrease the discounting of gains, we need to *decrease* impatience. For losses, however, impatience (i.e., the desire to get the loss over with now) translates to lower discounting. Therefore, to decrease discounting of losses we need to *increase* impatience.

There are multiple approaches to changing people's behavior. First, we can change behavior by altering the ways in which people approach and make decisions. As shown in Study 2, directing participants to explicitly consider arguments for two intertemporal choice options in the unnatural order (i.e., in the order *opposite* to the natural and implicit tendency to consider reasons favoring the default option first and reasons favoring the alternative option second) eliminates the direction effect for gains and for losses. Such "consider the alternative option first" approaches have also been successfully used in applied intertemporal choice scenarios, such as Social Security retirement benefit claiming (Appelt et al. 2011).

Second, we can alter how decisions are presented to "nudge" people to make better decisions (e.g., Thaler and Sunstein 2008). For intertemporal choices, we can change the default

option. For gains, we can decrease impatience, and therefore discounting, by making the later option the default option. For losses, we can increase impatience and decrease discounting by making the sooner option the default option. The success of such interventions for gains has been demonstrated behaviorally by Weber et al. (2007), and the neural process implications, including less activation of brain regions known to code response conflict and self-control when the later option is the default, have been shown by Figner et al. (2010). Another way to alter the presentation of decisions is to reframe them. For intertemporal choices, we may be able to reframe gains as losses (e.g., emphasizing the loss of savings rather than the gain in spending money) in order to decrease discounting.

Both changing how people approach choices and changing how choices are presented are ways to facilitate more patient intertemporal choices that inspire less regret by decision makers. Which method is preferable will depend on which method is more natural in a particular context. For health behaviors, it may be relatively simpler to change the default. A successful example of this is the change in New York City law from "smoking allowed" in restaurants and bars to "no smoking allowed" in restaurants and bars (Weber et al. 2011). For financial decisions, it may sometimes be easier to reframe the options. Thaler and Benartzi's (2004) extremely successful Save More Tomorrow plan reframes losses to consumption as gains to saving (by coupling increases in savings and raises in salary). The studies reported in this paper show that changing the presentation of choices is not the only way to change behavior. People can also be prompted and trained to consider the opposite first (i.e., consider the alternative option before the default option). Whether with changes to how options are considered or how decisions are presented, giving people the tools to change the prominence of their impatient "act now" thoughts when faced with intertemporal decisions will arm them against making decisions they may later regret.

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Tables

Table 1 Summary of mean discount rates illustrating the sign by direction interaction, as reported in previous studies

		k		
	Source	Delay		Acceleration
Immediate vs. Future Gain	Benzion et al. 1989	27%	>	18%
	Shelley 1993	20%	>	15%
Immediate vs. Future Loss	Benzion et al. 1989	17%	<	24%
	Shelley 1993	11%	<	18%

Table 2 Descriptive statistics for *k* in Study 1

		k		
Condition	*N*	*M*	*SD*	*Range*
Gain delay	115	1.29	1.09	4.40
Gain acceleration	112	0.99	1.31	5.80
Loss delay	184	0.00	0.75	3.60
Loss acceleration	196	0.58	1.09	3.60

Table 3 Descriptive statistics for *k* in Study 2

Condition		*N*	*k*		
			M	*SD*	*Range*
Natural Thought Order	Gain delay	33	1.25	0.97	4.00
	Gain acceleration	33	0.62	0.72	2.89
	Loss delay	41	-0.04	0.84	4.40
	Loss acceleration	34	0.44	0.71	2.89
Unnatural Thought Order	Gain delay	34	0.98	0.71	3.60
	Gain acceleration	37	0.90	0.88	3.63
	Loss delay	33	0.30	0.92	4.40
	Loss acceleration	34	0.54	1.13	5.59

Figures

Fig 1 Discounting by sign (gain vs. loss) and by direction (delay vs. acceleration) in Study 1. Higher values of *k* indicate greater discounting. Error bars show +/- one standard error

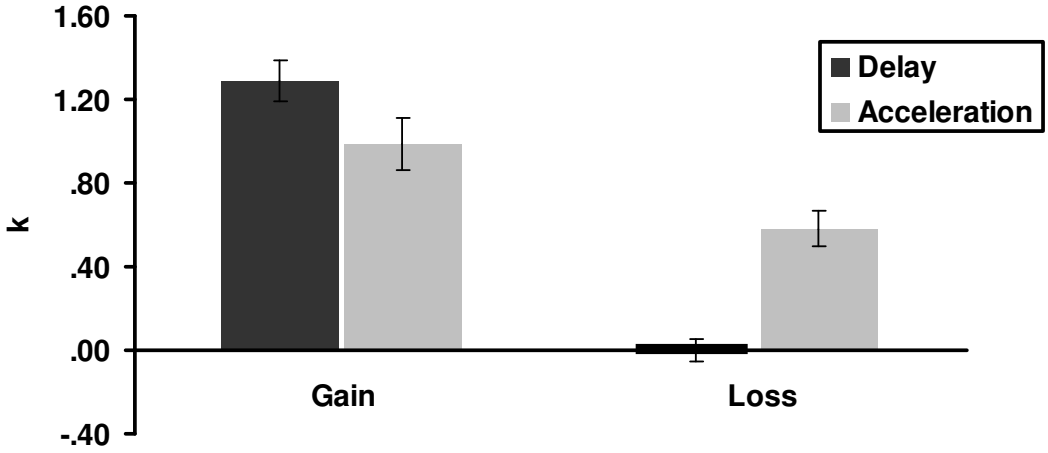


Fig 2 The prominence of now thoughts by sign (gain vs. loss) and by direction (delay vs. acceleration) in Study 1. A greater prominence of now thoughts indicates more and earlier thoughts in favor of the smaller, sooner amount. Error bars show +/- one standard error

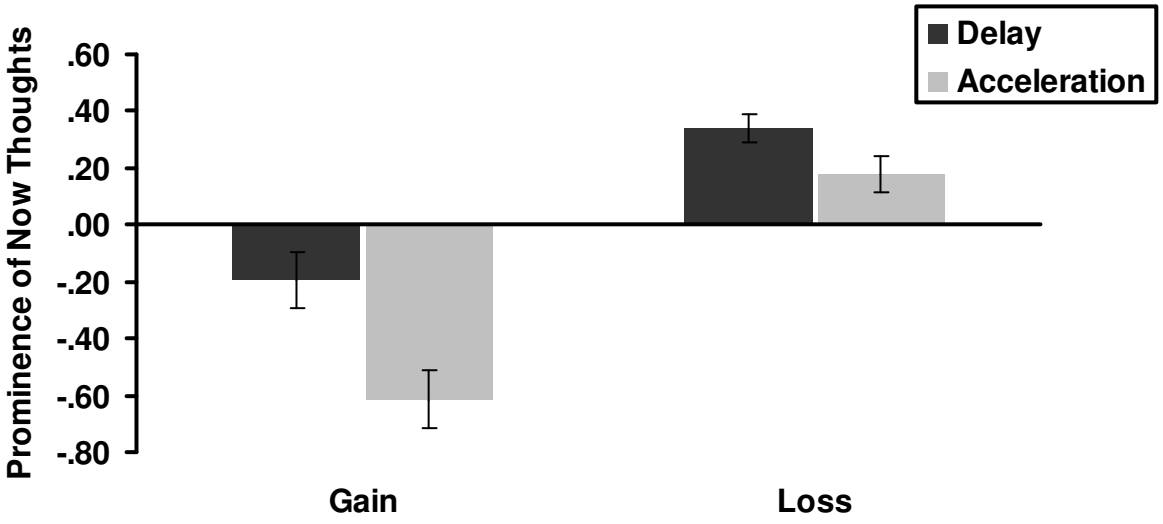


Fig 3 The prominence of now thoughts significantly mediates the effect of direction (delay vs. acceleration) on discounting for gains (3a) and for losses (3b)

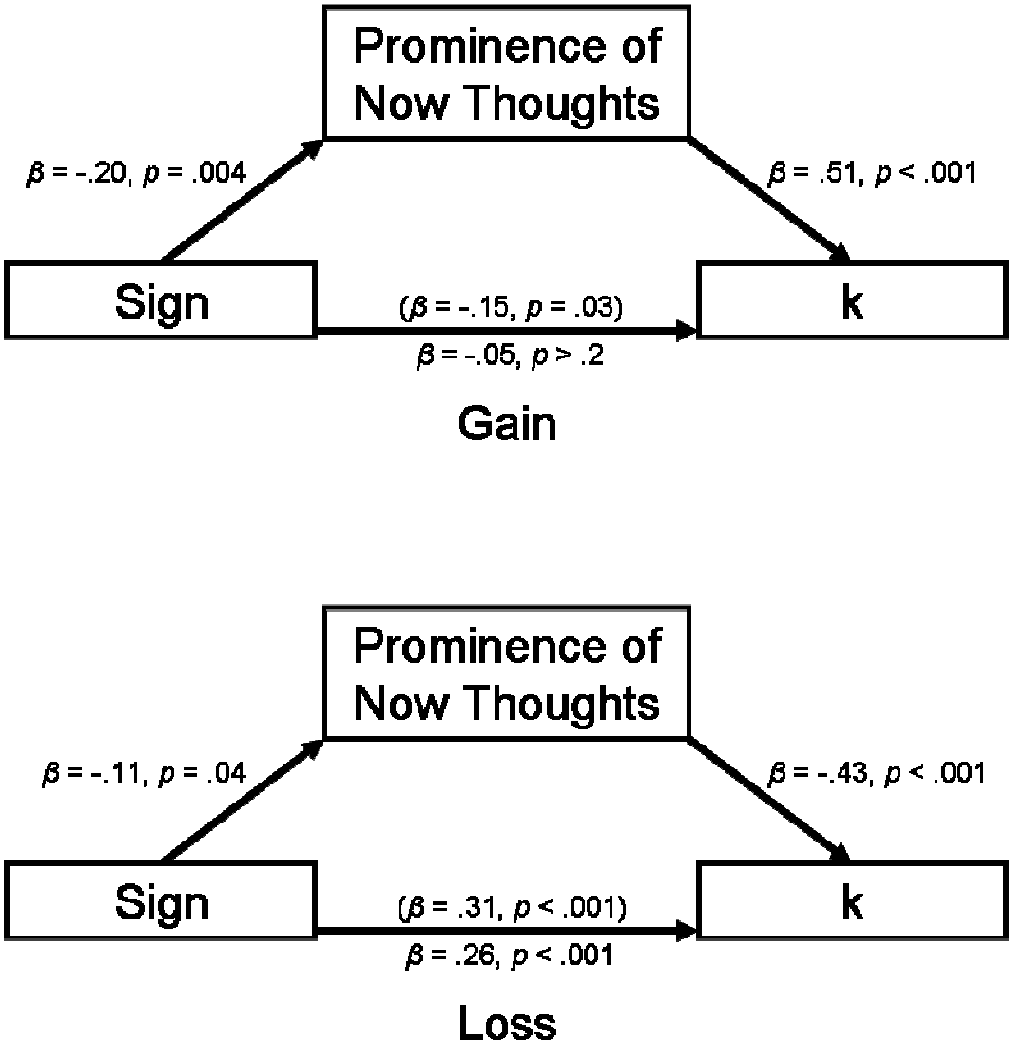
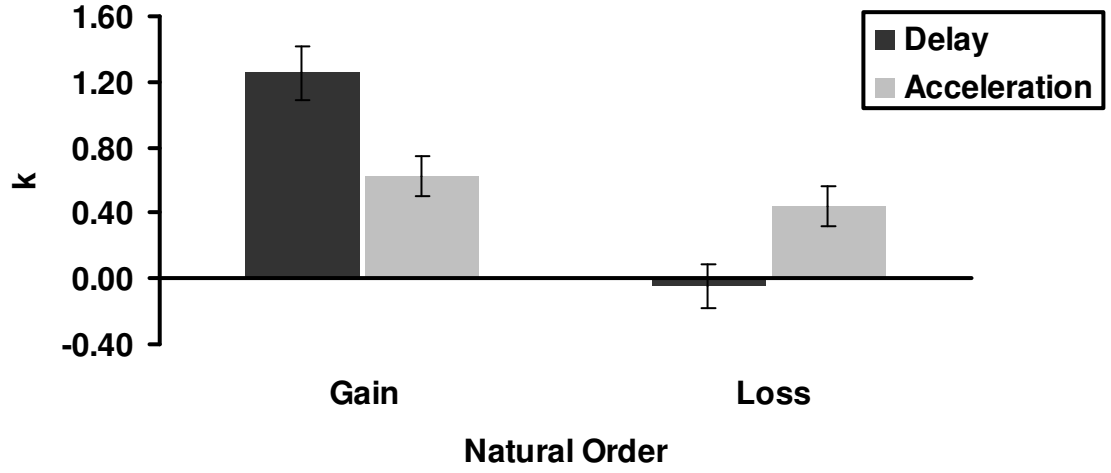


Fig 4 Discounting by sign (gain vs. loss) and by direction (delay vs. acceleration) in Study 2 for the natural order (4a) and for the unnatural order (4b). Higher values of *k* indicate greater discounting. Error bars show +/- one standard error



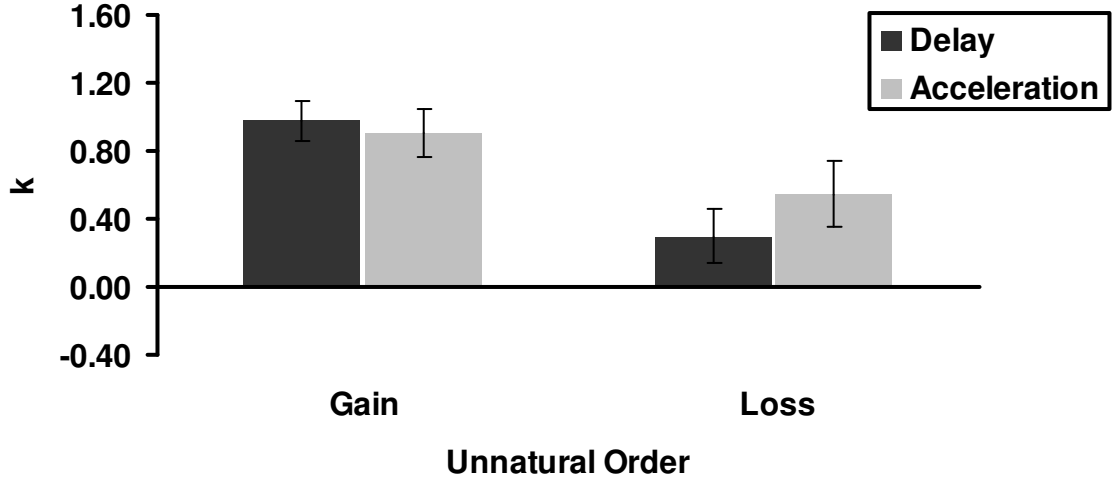
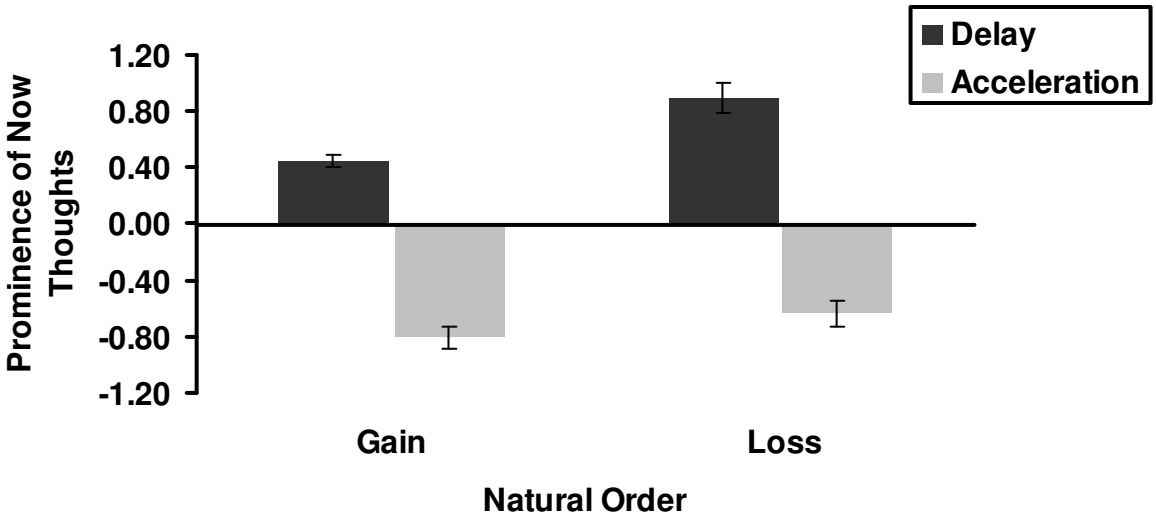
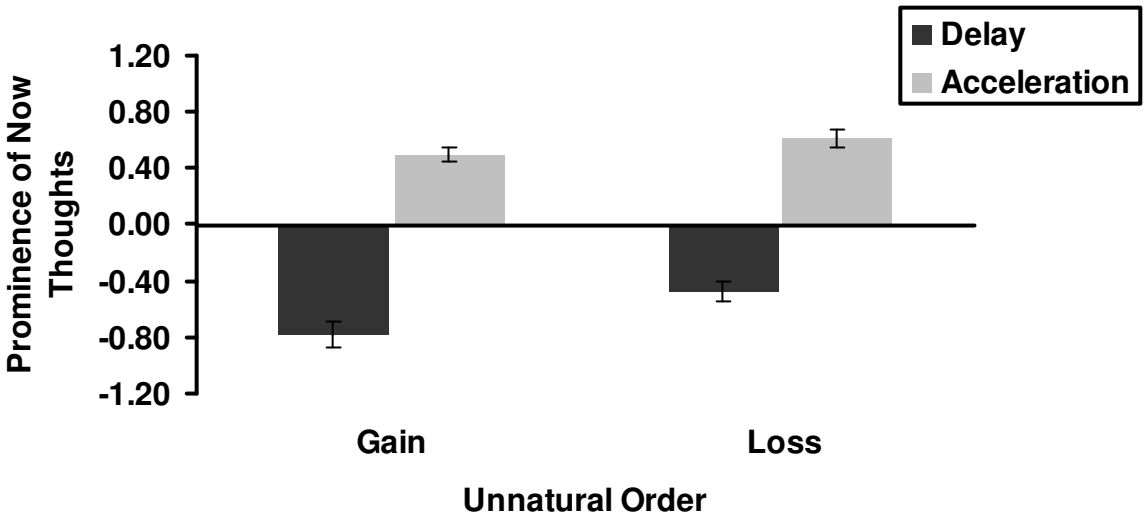


Fig 5 The prominence of now thoughts by sign (gain vs. loss) and by direction (delay vs. acceleration) in Study 2 for the natural order (5a) and for the unnatural order (5b). A greater prominence of now thoughts indicates more and earlier thoughts in favor of the smaller, sooner amount. Error bars show +/- one standard error





Appendix A: Mediation of direction effect on relative number of now thoughts by thought order in Study 1

We tested the Query Theory prediction that the order of now thoughts (as measured by standardized SMRD) mediates the effect of direction (delay vs. acceleration) on the relative number of now thoughts (as measured by the standardized difference between the number of now thoughts and the number of later thoughts). Following the steps outlined by Baron and Kenny (1986) and Shrout and Bolger (2002), we ran a series of linear regressions. In step 1, we regressed the relative number of now thoughts (the dependent variable) onto direction, which was significant, $B = -0.10$, $SE = .04$, $t(561) = -2.33$, $p = .02$, *partial* $r^2 = .01$. In step 2, we regressed SMRD (the proposed mediator) onto direction, which was significant, $B = -0.16$, $SE = 0.04$, $t(561) = -3.75$, $p < .001$, *partial* $r^2 = .02$. In step 3, we regressed the relative number of now thoughts onto direction plus SMRD. Direction was no longer significant, $B = 0.00$, $SE = 0.03$, $t(560) = 0.07$, $p > .5$, *partial* $r^2 < .01$. As predicted, SMRD *was* significant, $B = 0.66$, $SE = 0.03$, $t(560) = 19.53$, $p < .001$, *partial* $r^2 = .41$. Bootstrapping tests (as recommended by Shrout and Bolger 2002) confirmed that the order of thoughts significantly fully mediated the relationship between direction and the relative number of now thoughts, $p < .001$. As predicted by Query Theory, when the smaller, sooner amount was the default, thoughts in favor of it clustered earlier in participants' thought listings, which led to relatively more thoughts in favor of receiving/paying now.

Appendix B: Mediation of direction effect on discounting by prominence of now thoughts in Study 1

To test whether the effect of direction (delay vs. acceleration) on discounting was mediated by the prominence of now thoughts, we tested for mediation following the steps outlined by Baron and Kenny (1986) and Shrout and Bolger (2002). We ran a series of linear regressions separately for gains and for losses.

For gains, in step 1, we regressed discounting (the dependent variable) onto direction, which was significant, B = -0.18, SE = .08, $t(206)$ = -2.14, p = .03, *partial* r^2 = .02. In step 2, we regressed the prominence of now thoughts (the proposed mediator) onto direction, which was significant, B = -0.21, SE = 0.07, $t(206)$ = -2.95, p = .004, *partial* r^2 = .04. In step 3, we regressed discounting onto direction plus prominence of now thoughts. Direction was no longer significant, B = -0.06, SE = 0.07, $t(205)$ = -0.75, $p > .2$, *partial* $r^2 < .01$. As predicted, the prominence of now thoughts *was* significant, B = 0.59, SE = 0.07, $t(205)$ = 8.33, $p < .001$, *partial* r^2 = .25. Bootstrapping tests (recommended by Shrout and Bolger 2002) confirmed that the prominence of now thoughts significantly fully mediated the relationship between direction and discounting for gains, p = .004. When the smaller, sooner gain was the default, thoughts in favor of receiving now were more prominent, which translated to greater discounting of gains.

For losses, in step 1, we regressed discounting (the dependent variable) onto direction, which was significant, B = 0.30, SE = .05, $t(353)$ = 6.12, $p < .001$, *partial* r^2 = .10. In step 2, we regressed the prominence of now thoughts (the proposed mediator) onto direction, which was significant, B = -0.08, SE = 0.04, $t(353)$ = -2.06, p = .04, *partial* r^2 = .01. In step 3, we regressed discounting onto direction plus prominence of now thoughts. Direction remained significant, B = 0.26, SE = 0.04, $t(352)$ = 5.77, $p < .001$, *partial* r^2 = .09, but its effect was reduced. As predicted,

the prominence of now thoughts was significant, $B = -0.56$, $SE = 0.06$, $t(352) = -9.43$, $p < .001$, *partial* $r^2 = .20$. Bootstrapping tests confirmed that the prominence of now thoughts significantly partially mediated the relationship between direction and discounting for losses, $p = .03$. When the smaller, sooner loss was the default, thoughts in favor of paying now were more prominent, which translated to lower discounting of losses.